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The Theory of Savanna Planation

C. A. COTTON

The savanna "cycle"

THE INSELBERG LANDSCAPE (*Inselberglandschaft*) as described by Bornhardt[1] has also been called the "savanna landscape"; and the concept of a "savanna cycle" has been introduced in an attempt to explain its origin.[2] This landscape type, which is common in the tropics, is characterized by a great extent of very smooth, nearly level plains which are flooded in the wet season. From the plains inselbergs rise abruptly, i.e., very steep-sided isolated hillocks and hills, even mountains, of more or less bare rock.

Some examples of inselberg landscapes in a broader sense,[3] with less truly level plains though in other respects they superficially resemble the savanna landscape, are found in regions that are now semi-arid, where they have been either developed or at least much modified in form by the pedimentation process; these are better described as pediplains with residual inselbergs. In contrast with these, savanna landscapes, or inselberg landscapes in the strict sense, seem to have originated in hot climates that were more humid, notably in the climate that now prevails in the savanna belts ("humid savanna" of Büdel), in which development of this landscape type seems to be still in progress. In these belts, equatorward of the desert and semi-arid zones (including "desert savanna" and "thorn savanna" of Büdel[4]) the climate is hot all the year round and has alternating wet and dry seasons, the latter relatively short but sufficiently well marked (about three months in length) to interfere to some extent with the growth of forest. Büdel, who has discussed the origin of the savanna landscape, concludes that it develops also in the moist equatorial climate (with shorter dry seasons) that encourages the growth of rain forest, and in the monsoon-forest regions as well.[5] Significantly, Büdel now maps the equatorial forest and "humid" savanna zones as one.[6] In all such regions high temperature prevails at all seasons.

Tricart and Cailleux claim that savanna landscapes in general are "polygenetic", i.e., partly relict assemblages which have been developed for the most part by pediplanation in an earlier semi-arid episode or episodes which affected equatorial regions in the Quaternary. They admit that in the savanna belt plains have been thoroughly smoothed by the washing of fine silt from the higher parts of (presumably) pediplaned surfaces into hollows during the present-day phase of relatively humid climate; but they deny the activity particularly in hot forest regions, but also in savanna regions, of vigorous erosion processes

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➤ Sir Charles Cotton, author of text-books dealing with various aspects of geomorphology, is Emeritus Professor of Geology of the Victoria University of Wellington, New Zealand.

such as could lead to planation. They claim indeed that, though chemical weathering is very active, erosion is now almost at a standstill in the equatorial belt except for the shaping of "sugarloaves" of crystalline rock, existing relief, necessarily relict, being conserved practically without any modification.[7] According to Büdel's theory, on the other hand, the processes of savanna planation are indigenous to hot-humid climates and have not been interrupted by Quaternary changes of climate. In other words, the savanna-plains landscape is "monogenetic" and a uniformitarian approach to its study seems therefore to be justifiable.

Examples of active savanna planation

Savanna planation seems to be active on the plain bordering the Gulf of Guinea at Accra and on the vast Wute Plain (altitude 1500–2000 feet) in the Central Cameroons.[8] The latter plain, as described by Sapper,[9] following F. Thorbecke, and by Clayton, abuts at the rear against a retreating scarp, 1500 to 2000 feet high and 70 miles long, bounding the Ndomme Plateau to the north (Fig. 1). Both these savanna plains are in the Gulf of Guinea "refuge", in which, as suggested by Tricart and Cailleux,[10] the equatorial rain forest survived through the Quaternary, thus excluding the alternative theory that planation took place during, and may have been restricted to, relatively arid episodes.

The mechanics of savanna planation

Büdel has noted that the rivers on a developing savanna plain are not normally incised in it even in the shallowest of valleys but flow over its surface, or rather flood in the wet season, in ever-shifting courses.[11] Allowance being made for an enormous difference in scale, the pattern of such rivers and their mode of operation recall the braided stream courses on a rock fan. The latter, as pointed out by Johnson, are constantly shifting and eroding laterally, so that they wear the rock surface down evenly in the shape of a fan.[12] Such, according to Büdel's theory, is the mechanism of a slow downwearing and shaping of the surface to river gradients, in this case gentle gradients, on a savanna plain—a process which must, of course, be interrupted many times by the temporary deposition of fine alluvium. The rivers engaged in this process rarely encounter solid rock, and do not erode it anywhere, as their load does not include any coarse waste. They erode only by washing away fine particles of the red[13] surface soil of an intensely weathered regolith whose very considerable thickness is maintained by progressive rock decay below. This washing, which takes place when, in the wet season, the water table is high and streams overflow widely, is more or less analogous to the sheetwash invoked by King as the chief agent of pediplanation. Büdel remarks that it is "wash" and not any

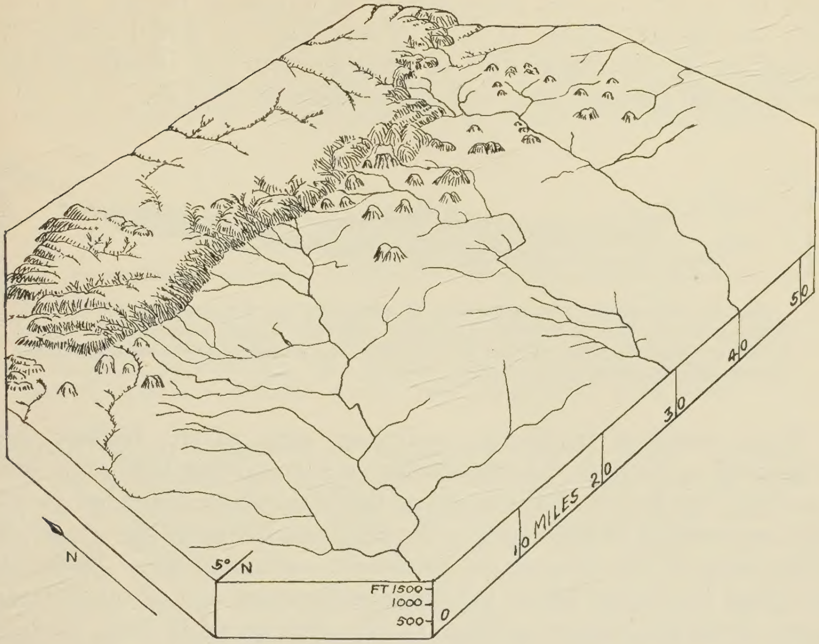

Fig. 1.—Block diagram showing the Wute Plain backed by the scarp of the Ndomme Plateau, Central Cameroons (after Clayton).

kind of mass movement that conveys fine waste into the main rivers and thus lowers the surface of the plains.[14]

Büdel insists on the presence of a thick zone of material weathered in place beneath the smooth savanna plain (Fig. 2). Such deep weathering is denied by Tricart in a review of Büdel,[15] but it has been reported by Clayton, who has also quoted Thorbecke's observation of "many metres" depth.* Büdel describes, moreover, how the thickness of the regolith varies very much from place to place, especially where the lithology of the terrain is heterogeneous so that some of the rocks composing it yield more readily to rock decay and are therefore more deeply rotted than others. Thus beneath a regolith of great but very variable thickness (up to 100 feet and perhaps in places hundreds of feet) lies a very uneven basal surface of unaltered terrain (Fig. 2).* This concept of "double surfaces of levelling", as Büdel names it, is important for the explanation of the numerous low inselbergs which are scattered through most savanna landscapes (Fig. 4).

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* In the opinion of Dresch[16] the cover of fine red soil overlying bedrock under savanna plains in the western Soudan has not resulted from alteration of the bedrock. He claims that it is an alluvial deposit that has been brought by rivers from the south in Tertiary times and spread thinly over a very perfectly planed ancient surface, a pediplain from which inselbergs project up through the cover while the pediments around these are buried. Erosion, rather than further accumulation on the plain as a whole, is now in progress, but this is so slow as to be almost negligible. These plains are very nearly, though not quite, level, with a labyrinthine pattern of flood-time rivers in broad, shallow hollows, where the flow is very sluggish and liable to reversal. Though the Soudanese plains closely resemble those of the West African coastal region in some respects, their senile condition after survival for twenty million years or more (if this conclusion, reached by Dresch, is correct) renders them of little value, as compared with the other examples cited, for the study of processes that operate when savanna planation is active.

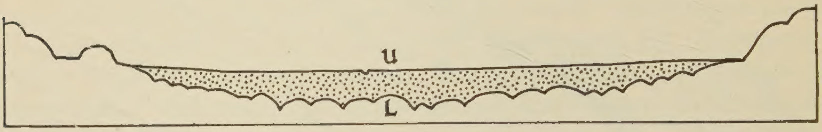

Fig. 2.—Schematic representation of planation in the savanna cycle, with development of "double surfaces of levelling" (Büdel). U, upper (subaerial) surface; L, lower (subterranean) surface at the base of the zone of weathering. Great vertical exaggeration. (After Büdel.)

Some marginal inselbergs, including some of the highest, have originated as outliers of neighbouring or surrounding highlands which have become frayed at the edges as the plains have extended at their expense, making embayments in the highland margins (Fig. 4), as takes place also in the process of semi-arid pedimentation. Such high marginal inselbergs fringe the embayed eastern end of the Ndomme scarp, Central Cameroons (Fig. 1). In contrast with these, however, ubiquitous, scattered, and generally smaller inselbergs are shaped by erosion from initial forms which have come into existence, according to Büdel's theory, when up-jutting unweathered salients of the unevenly decayed deep floor have emerged as a result of a general ablation, or erosional lowering, of previously levelled savanna plains (see Figs. 3 and 4). Weathering and erosion have shaped these inselbergs ("shield inselbergs" of Büdel) into domical and tor-like forms. In some cases at least the erosional lowering of the plains surface has been intermittent, being caused, as Büdel postulates, by the entry of the savanna plains on new cycles of planation due to relative sinking of base level, presumably caused in most cases by spasms of sensibly uniform upheaval.

Büdel's explanation differs but little from that proposed by Willis, who also ascribes the durability of the cores that make inselbergs to relative immunity from weathering of the rock types in them, and who envisages their survival as landforms through successive geomorphic cycles with an immensely long time span.[19] This theory of polycyclic origin allows for growth to great height, provided an almost perfect immunity from erosion is conceded. According to J. Dresch, cited by

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* It is sometimes assumed (by the writer for example[17]) that at least in temperate regions alteration of the nature of "weathering" takes place only in a zone of aeration above the lowest dry-season position of the water-table; but, on the other hand, in the hot equatorial climate of Singapore some such alteration is in the opinion of Alexander going on in a deeper zone that is continuously saturated with water and is thus never aerated—so that there is no downward limit.[18] Probably because of the extreme rapidity with which she found chemical changes taking place, Dr. Alexander ignored the remote possibility that the zone of deep alteration she observed was in part relict from the late-Glacial low stand of sea level, alteration having thus begun in an aerated zone.

Birot, some Saharan monolithic domes have survived for tens of millions of years, increasing in relief through a succession of cycles.[20] The polycyclic theory may afford an explanation of many of the high sugarloaf or domical inselbergs "developed only in rocks of plutonic origin" to which King has attempted to restrict the name *bornhardt*[21] (suggested by Willis in 1936 as a substitute for inselberg). The domical form of these is governed solely by their lithology and monolithic character; and Birot confirms the view (*cf.* Cotton and King)[22] that such "crystalline" domes are "azonal", i.e., not peculiar to any climatic zone, being "found from Arctic latitudes to the domain of the equatorial forest". He thus throws doubt on the correctness of the claim made by Tricart and Cailleux that sugarloaf forms are produced by a special process of erosion peculiar to the equatorial rain-forest belt.

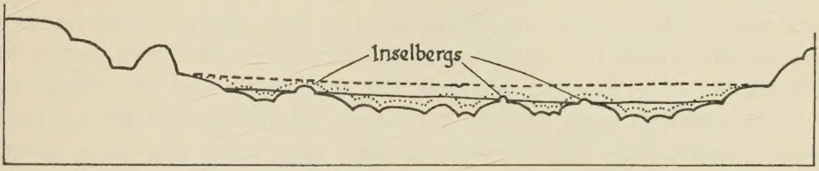


Fig. 3.—Savanna planation at successive levels. In the latest cycle residual unweathered cores of rock have escaped planation and their outcrops have assumed the form of inselbergs. Great vertical exaggeration. (After Büdel.)

While over the whole extent of the savanna plains the land surface is, according to the theory of Büdel, being lowered by weathering *below* and by wash *at* the plains level, the area occupied by the savanna landscape is being enlarged by the marginal encroachment of pediments beyond the feather edge of the regolith of the plains on to the less thoroughly weathered, scarp-bounded rocks of inselbergs and also, more especially, of bordering uplands or highlands (Fig. 4).

It seems to be a mistaken theory that streams of water flowing along "scarp-foot depressions" have hastened the sapping back of scarps either directly by lateral corrasion or indirectly by stimulating pedimentation along the scarp bases (in 1942 the writer favoured this theory). Linear scarp-foot depressions, though these are common, have been shown by Clayton to be in general minor features which, however they originate, are not and have not been river courses. Büdel ignores the possibility that lateral corrasion by rivers plays any part at all in cutting back upland scarps. Savanna plains are obviously enlarged, however, by retreat of the scarps that hem them in, and such scarp retreat must, if the theory of lateral stream planation be rejected, be due entirely to a process rather closely analogous to semi-arid pedimentation; but scarp-foot pediments, though present, are quite narrow and slope but gently—at a maximum of 3° according to Büdel and to measurements made by Clayton in Ghana. Though, as Clayton observes, the smoothness of profile may be broken by the presence of a problematical scarp-foot depression the narrow pediments merge generally into the savanna plains with decreasing slope.

It is the restriction of the pedimentation process to the margins of "wash" plains which may be of great extent that distinguishes this cycle of planation from the semi-arid cycle, in which pediments are much more widely developed, extending all the way down to the banks of streams into which the waste produced by erosion in the extension *and down-planing* of pediments is swept by sheetwash and by which this waste is carried away. It is, moreover, characteristic of semi-arid plains (pediplains) that "even ancient and very flat [i.e., nearly horizontal] pediments often show beneath a thin layer of transported material a smoothly cut, unweathered rock surface".[23] Semi-arid pedimentation, being, unlike savanna planation, a mechanical process taking place in a climate not conducive to the destruction of rock fragments by chemical weathering, is regarded as rapid in its operation.[24]

Marginal pediments that border a savanna plain, being composed of firm (if not entirely unweathered) rock with little or no regolith, may survive as residual benches if the plains surface is lowered in a new cycle following a sinking of base level and a new scarp develops between upland and plains (Fig. 4). This, according to Büdel, is the explanation of piedmont benchlands.

The time scale

The scarp descending from the Ndomme Plateau in Central Cameroons (Fig. 1) is a feature on so grand a scale as to furnish an impressive reminder of the immensity of the time required for the savanna planation and accompanying scarp retreat that have produced the Wute Plain at its foot. Such a plain is enlarged only by retreat of the scarp at its rear, and the process of pedimentation at the foot of this Ndomme scarp appears to operate rather slowly; but however slowly the scarp as a whole retreats its retreat keeps ahead of potential dissection both of the scarp and of the plateau above it such as would take place if consequent and insequent valleys were to develop vigorously. Dissection by such valleys would assuredly assume control if cool-humid conditions of climate like those prevailing in middle latitudes were to supervene. The present scarp would then become an initial form for dissection in a "normal" geomorphic cycle, just as slopes more or less similar to it but of tectonic origin which came into existence in the Quaternary in mobile regions (New Zealand for example) have been dissected.[25]

A high scarp like this must be immensely old in years, though when judged by criteria that might be applied in a cool-humid climate where dissection by streams is in progress it appears to be topographically young. Its "youth" is perennial, however, being due not to rapidity of development—though the question remains open whether the absolute

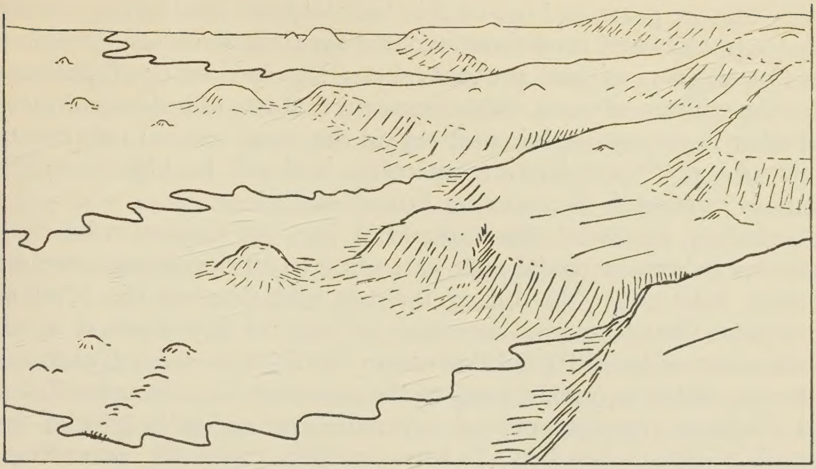


Fig. 4.—Schematic representation of savanna planation in two cycles. The rear part of a savanna plain now developing (at the left) is separated by a scarp-foot pediment and scarp from a residual upland. Rivers plunge over waterfalls at the front of the upland, which is not dissected but is bordered by the residual margin of the plain formed in an earlier cycle. High marginal as well as lower scattered inselbergs are shown. (After Büdel.)

rate of its development is or is not very slow—but to inhibition of the competing process of valley erosion. Such inhibition of valley erosion in the hottest parts of the tropical belt is well attested by various observers[26] who agree that its cause is the intensity at high temperatures of chemical weathering, which by breaking down rock fragments into fine debris deprives running streams of gravel and even of coarse sand wherewith to corrade their beds and so to deepen and grade their channels in solid rock.[27] (Compare Fig. 4: the upland at the right is undissected, for, owing to inhibition of vertical corrasion, rivers plunge over the edge of the scarp as waterfalls.)

It is worth while emphasizing the fact that inhibition of normal erosion is governed by a combination of high temperature and humidity, not by low latitude. It seems not to dominate all forested tropical regions to the extent implied by Tricart and Cailleux. In the Fiji Islands, for example, though in latitude 15° S, a forested landscape has been dissected by maturely graded rivers.[28] In the Samoan Islands also dissection under forest is going on rapidly.[29]

Inhibition of the cutting of valleys by corrasion is a sufficient explanation of the dominance of scarp retreat in savanna planation, and it has not been suggested that the backwearing of scarps ever takes place rapidly. Rather is planation by this means far advanced, in regions that have continuously experienced hot-humid conditions and have also escaped recent upheaval, because of the vast length of the period during which it has been in operation. Glacial-age lowerings of temperature were never very strongly marked in the equatorial belt, amounting, according to Büdel, to only 1° or 2° C, and there seems no doubt that in parts at least of this belt tropical weathering went on uninterruptedly and conditions favoured savanna planation throughout the Quaternary, as had probably been the case in pre-Quaternary times for millions of years. Büdel remarks that it is of little consequence "whether in an equatorial coast region the mean annual temperature is 26° or 24°";[30] the latter temperature will still be high enough to promote rapid rock decay under humid conditions.

According to Büdel the equatorial belt of tropical rain forest increased in area in glacial ages, extending (with the closely associated savanna belt) to 15° N during the last glaciation of the Northern hemisphere; but it may be necessary to limit the hypothesis of secular continuance of humid conditions from Tertiary through Quaternary to Recent times to certain parts of the equatorial belt because Tricart and Cailleux cite evidence of a pronounced swing in glacial ages towards aridity in that belt. In interior Africa especially, according to their view, this may have caused interludes of semi-aridity or even in some places of extreme aridity, when forests must have been exterminated and semi-arid pedimentation—a rapidly acting process because of the mechanical erosion involved—must have supervened over large areas. Thus a history of secular savanna planation may be questioned in the case of some existing inselberg landscapes in low latitudes. The coast of the Gulf of Guinea has been suggested, however, by Tricart and Cailleux as one of a few "refuges" in which the tropical rain forest has survived through Quaternary arid episodes. If the suggestion is well founded this region, in which extensive savanna plains have been described that are still developing, must have escaped all episodes of arid or semi-arid erosion. It thus seems that these plains must be in a cycle of secular savanna planation.

Accidents and interruptions

Besides plains of savanna planation that are at present developing there are other plains presumably of similar origin that are now youthfully dissected by numerous river valleys of moderate depth, perhaps as a result of upheaval.[31] There are also many in various parts of Africa from which, according to Büdel's interpretation, the thick regolith normally underlying a savanna plain has been stripped away. Such removal may take place as a result of regional or local change to a cooler climate (which may accompany a lowering of base level); and the same result may follow in the tropical belt without regional change of climate if a savanna plain is upheaved to become a very high and therefore cool plateau. Stripping away of the regolith by erosion at a rate so rapid that newly weathered debris is not produced as rapidly at the bottom of the layer may eventually lay bare the unweathered bedrock; the uneven surface of this will then be exposed so as to roughen the surface of the plateau.

A similar stripping must follow a local change of climate towards aridity, such as was brought about at the beginning of the Quaternary, when, according to Büdel, climatic zones similar to those of the present day were first established and the previously existing immensely broader zone of savanna and rain forest climate contracted to a comparatively narrow belt near the Equator. Thus originated the desert plains of the southern Sahara and Somaliland.[32] Such an "accident" introduces an entirely new morphogenetic system. Under an arid regime deflation by wind, with sorting of the now desiccated material of the regolith into sand and dust, takes place rapidly. The sand being collected into ergs and the dust exported, it is possible for the underlying fresh rock to become exposed and to have its unevenness revealed, the salients of bedrock being now shaped into desert forms. Moreover, much dissection by valleys has also taken place in high-standing areas that are now arid—as in the Ahaggar region of the central Sahara. In those areas that are now the driest deserts, most of Quaternary time, with the exception of one or more "pluvial" episodes, has been available for these processes.

In pre-Quaternary times, on the other hand, there were presumably no deserts in Africa, the equatorial forest and humid savanna belts being very wide. Extensive plateau remnants in the Ahaggar, for example, have been recognized as relics of late-Tertiary inselberg-dotted savanna plains, afterwards upheaved, on which the characteristic red regolith has locally been preserved under basalt sheets.[33] The theory of the arid geomorphic cycle as developed by Davis, which deduced the development of desert plains from initial landscapes of possibly strong tectonic relief, demanded an immense lapse of time during which average conditions favoured arid erosion—many millions of years.[34] If there were no pre-Quaternary deserts in Africa, this rules out the concept of such desert planation. If, however, aridity has prevailed over large areas for some considerable fraction of a million years during the Quaternary it seems obvious that there has been ample time for the conversion of landscapes that had originated as savanna plains into typical arid-desert plains.

In North and South Africa initial surfaces on which the semi-arid pediplanation cycle as described by King[35] afterwards developed may also have been savanna plains inherited from pre-Quaternary times.

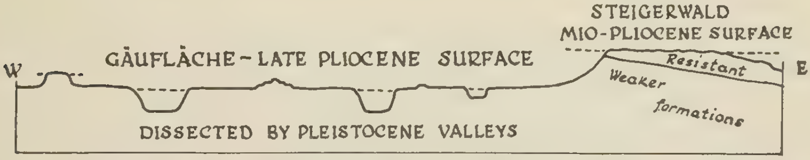
Tertiary peneplains

It is claimed by Büdel that savanna, or "tropical", planation not only accounts for existing inselberg landscapes, whether these remain as savanna plains that are still developing or have been upheaved or have become desiccated, but also has been the cause of the erosional development of so-called peneplains and piedmont benchlands in middle-latitude regions. This hypothesis was foreshadowed by Jessen and has been proposed also by Louis.[36] If it affords a correct explanation, these surfaces even if they were found undissected must be classed as relict forms which developed when (in the Tertiary) a "tropical" climate such as is now restricted to low latitudes extended far across the middle-latitude belts.

In middle-latitude regions the hot-humid climate of the Tertiary was eventually replaced by the Quaternary cool to cold climate. During glacial ages, and also in the less cold interglacial and post-glacial times, dissection by streams and in particular the cutting of deep valleys by rivers have radically re-shaped the landscapes, destroying, according to Büdel, former widespread plains of savanna planation or reducing them to small remnants. These survive generally on major divides and on the interfluves between the branches of large rivers near their headwaters. Upheaval of the land has taken place to a greater or less extent in most places in the Quaternary, even where such uplift has not been great enough to produce mountain ranges, and the possibility of eustatic lowerings of ocean level must also be considered as a stimulus to vertical corrasion. According to Büdel's theory, however, the almost ubiquitous deep incision of river valleys which has dissected the formerly planed surfaces, entirely destroying them in some regions, has been made possible only by a change in the erosive capacity of the rivers themselves.[37] Rivers in middle latitudes flow now in valleys graded to gentle gradients, so that farther and farther from the river mouths their valleys are incised to greater and greater depths (until the ungraded headwaters are approached). When, in earliest Quaternary times, the climate became cool the capacity to cut these deep valleys was acquired by the rivers as a result of the supply to them of abundant coarse waste such as they have since been making use of as tools of corrasion, but which was formerly very scarce or absent, as it is now in the equatorial belt of intense chemical weathering. The availability for the first time of tools of corrasion thus led to the dissection of middle-latitude regions, in particular Europe, bringing abruptly to a close a widespread and long-enduring inhibition of valley cutting. As regards time available, the million years of Quaternary time seems adequate for the dissection of Europe, if the tempo of erosion was anything like as fast as it is known to have been in New Zealand.

As the hypothesis of peneplanation by downwearing of the land surface presupposes a thorough dissection of the landscape by valley cutting in a "mature" stage of the geomorphic cycle, acceptance of a theory of inhibition of valley cutting and *therefore of dissection* in pre-Quaternary times rules out the explanation of Tertiary surfaces as true peneplains produced by downwearing. It compels the adoption of some hypothesis that explains planation as due to progressive destruction of residual uplands by backwearing. Just as in tropical Africa the margins of plateaux are worn back so that they give place gradually to new savanna plains, so in Europe in Tertiary times upraised "peneplains" were gradually replaced by others graded to lower base levels, and this may have taken place without progressive dissection. Alternative to savanna planation there is the suggestion made by Tricart and Cailleux of semi-arid pediplanation.[38] Baulig—who himself favours a theory of true peneplanation—has pointed out, however, that late-Tertiary Europe, as indicated by fossil floras, was warm and *humid* without signs of arid or semi-arid episodes.[39]

The validity of the foregoing explanation of the middle-latitude landscapes as subject to savanna planation by backwearing at successively lower levels in the very late Tertiary and as suffering dissection by deeply cut valleys *only* in the Quaternary depends on the correctness of Büdel's contention that not merely warm but really "tropical", hot-humid conditions persisted in Europe *until the end of the Pliocene*, when cooling took place suddenly, perhaps at the onset of the earliest Quaternary glaciation. A hot climate is generally believed to have prevailed in Central Europe in early to middle Tertiary periods, with the temperature 10° to 12° C. above that of the present day.[40] Büdel, however, writes: "Evaluation of upper Pliocene pollen analyses reveals that the forests then consisted of a mixture of Central European and evergreen trees—often to the astonishment of paleobotanists. The conclusion may perhaps be justifiable that the Upper Pliocene hot climate of Europe resembled a sub-tropical monsoon climate".[41]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DISSECTED BY PLEISTOCENE VALLEYS

Fig. 5.—Profile of surfaces of planation in Franconia, showing the Gäufläche and the Steigerwald. (After profiles by Büdel.)

"Peneplains" in the Franconian basin are described by Büdel as typical extra-tropical examples of relics of plains of savanna planation that developed in late-Tertiary times. The most recently formed of these is preserved at an altitude of about 1000 feet on broad interfluves between valleys of Pleistocene origin in the vicinity of Würzburg. Naturally the development of this level surface, the Gäufläche, in late-Pliocene cycles destroyed plains similarly developed in earlier Pliocene cycles at somewhat higher levels, with the exception of some marginal remnants; but owing to peculiarities of geological structure quite large areas are preserved of a much higher (and slightly warped) plain of considerably earlier date, namely Sarmato-Pontian (Mio-Pliocene). This forms, for example, a plateau on the Steigerwald at an altitude of about 1600 feet, the boundary of which is a high structural escarpment (Fig. 5). The preservation of parts of this higher plateau on resistant stratified rocks, where it has alternatively been described as a non-cyclic structural plateau, resembles that of the peneplain forming the Colorado Plateau and of the East Australian peneplain where it survives widely on the nearly horizontal Hawkesbury Sandstone of New South Wales.

Rising above the level of late-Pliocene planation in Franconia there are low monadnocks which are explained by Büdel as inselbergs that projected up from a savanna plain. Above the level of Mio-Pliocene planation also there are monadnocks some of which are in this case truncated by relics of earlier-formed surfaces of planation, but the areal extent of these is not great.

In the Franconian basin relics of the late-Pliocene planed surfaces are at such uniform altitudes as to suggest that all the lowerings of base level that have affected them have been eustatic. In other parts of Central Europe, however, there have been uneven upheavals, and flights of step-like benches of late-Tertiary age (piedmont benchlands) on the flanks of mountain massifs can be accounted for as a result of such "updomings" interrupting savanna planation.[42]

REFERENCES

[1] W. Bornhardt, *Zur Oberflächengestaltung und Geologie Deutsch-Ost-Afrikas*, Berlin, 1900.

[2] C. A. Cotton, *Climatic Accidents in Landscape-making*, Christchurch and London, 1942.

[3] Cf. S. Passarge, *Panoramen afrikanischer Inselberglandschaften*, Berlin, 1928.

[4] J. Büdel, "The Ice Age in the tropics", *Universitas*, vol. 1, 1957, pp. 183–91, fig. 1.

[5] J. Büdel, "Die 'doppelten Einebnungsflächen' in den feuchten Tropen", *Zeitschrift für Geomorphologie*, vol. 1, 1957, pp. 201–28; and "Die Flächenbildung in den feuchten Tropen und die Rolle fossiler solcher Flächen in anderen Klimazonen", *Deutscher Geographentag Würzburg*, 1957, pp. 89–121, esp. p. 100.

[6] J. Büdel, "The Ice Age in the tropics", *op. cit.*, figs. 1 and 2. Büdel divides the Afro-European segment of the Northern hemisphere into climatic zones as follows: 0° to 12° N, tropical rain forest and humid savanna; 12° to 16° N, thorn savanna; 16° to 18° N, desert savanna; 18° to 32° N, desert; 32° to 34° N, desert steppe; 34° to 36° N, steppe; 36° to 45° N, evergreen Mediterranean forest; 45° to 69° N, summer-green deciduous forest; 69° to 74° N, tundra; 74° to 77° N, frost-debris zone; 77° to 90° N, glacier zone.

[7] J. Tricart and A. Cailleux, *Introduction à la géomorphologie climatique*, Paris, 1955, pp. 155 and 216–7.

[8] R. W. Clayton, "Linear depressions (*Bergfussniederungen*) in savannah landscapes", *Geographical Studies*, vol. 3, 1956, pp. 102–26, esp. figs. 1 and 11.

[9] K. Sapper, *Geomorphologie der feuchten Tropen*, Leipzig, 1935, pp. 103–7.

[10] J. Tricart and A. Cailleux, *op. cit.*, p. 153.

[11] J. Büdel, "Die Flächenbildungen in den feuchten Tropen . . .", *op. cit.*, p. 103.

[12] D. Johnson, "Rock planes of arid regions", *Geogr. Review*, vol. 22, 1932, p. 660.

[13] Red weathering takes place, according to W. L. Kubiëna only if there is a markedly hot dry season ("Uber die Braunlehmrelikte des Atakor (Hoggargebirge Zentral-Sahara)", *Erdkunde*, vol. 9, 1955, p. 126). Without this seasonal drought the regolith in the tropical zone is typically brown. The soil of part of the savanna plain near Accra described by Clayton (*op. cit.*) is black, but he remarks that such soil is rare in West Africa.

[14] Clayton, *op. cit.*, p. 116, agrees that the plains surface is progressively lowered by erosion, but suggests a different mechanism for this, namely a succession of sporadic "rejuvenatory incisions" of small stream valleys alternating with what amounts to peneplanation of the interfluves between them.

[15] J. Tricart, review of J. Büdel, "Die 'doppelten Einebnungsflächen' in den feuchten Tropen" in *Rev. Géomorphologie Dynamique*, vol. 9, 1958, p. 29.

[16] J. Dresch, "Plaines soudanaises", *Rev. Géom. Dyn.*, vol. 4, 1953, pp. 39–44.

[17] C. A. Cotton, *Geomorphology*, Christchurch and London, 1942, p. 17.

[18] F. E. S. Alexander, "Observations on tropical weathering . . .", *Quart. Journ. Geol. Soc.*, vol. 115, 1959, pp. 123–44.

[19] B. Willis, *East African Plateaux and Rift Valleys*, Washington (Carnegie Inst.), 1936, pp. 119 and 127.

[20] P. Birot, "Les dômes cristallins", *Mémoires et Documents*, vol. viA (1), 1958, Paris (C.N.R.S.), p. 33.

[21] L. C. King, "A theory of bornhardts", *Geogr. Journal*, vol. 112, 1948, pp. 83–7.

[22] P. Birot, *loc. cit.*; cf. C. A. Cotton, *Climatic Accidents in Landscape-making*, p. 99; and L. C. King, "The uniformitarian nature of hillslopes", *Trans. Edinburgh Geol. Soc.*, vol. 17, 1957, pp. 98–9.

[23] L. C. King, "Canons of landscape evolution", *Geol. Soc. America Bull.*, vol. 64, 1953, p. 743.

[24] J. Tricart and A. Cailleux, *op. cit.*, pp. 168 and 212.

[25] C. A. Cotton, "Fine-textured erosional relief in New Zealand", *Zeitschrift für Geomorphologie*, vol. 2, 1958, pp. 187–210.

[26] E.g. H. Baulig, *Essais de Géomorphologie*, Paris, 1950, p. 63; J. Tricart and A. Cailleux, *op. cit.*, p. 21; and J. Büdel, "Die Flächenbildung in den feuchten Tropen . . ." (*op. cit.*), p. 98.

[27] Cf. also E. de Martonne, "Problèmes morphologiques du Brésil atlantique", *Ann. de Géogr.*, vol. 49, 1940, p. 112.

[28] C. A. Cotton, "Fine textured erosional relief in New Zealand" (*op. cit.*), photo 3.

[29] D. Kear and B. L. Wood, "The geology and hydrology of Western Samoa", *N.Z. Geol. Surv. Bull.*, vol. 63, 1959, pp. 23–6.

[30] J. Büdel, "The Ice Age in the tropics" (*op. cit.*), pp. 186–7.

[31] See parts of block diagrams in Figs. 1 and 11 in R. W. Clayton, *op. cit.*

[32] Respectively J. Büdel, "Reliefgenerationen und plio-pleistozäner Klimawandel im Hoggargebirge", *Erdkunde*, vol. 9, 1955, pp. 100–15; and "Klimamorphologische Arbeiten in Aethiopien im Frühjahr 1953", *Erdkunde*, vol. 8, 1954, pp. 139–55.

[33] J. Büdel, "Reliefgenerationen und plio-pleistozäner Klimawandel . . ." (*op. cit.*), pp. 104–5 and W. Kubiëna, *op. cit.*, pp. 120–1.

[34] See especially W. M. Davis, *Die erklärende Beschreibung der Landformen*, Leipzig, 1912, figs. 142, 143; and C. A. Cotton, *Geomorphology*, Christchurch and London, 1942, fig. 258.

[35] L. C. King, *South African Scenery*, Edinburgh, 2nd edn., 1951, p. 52.

[36] O. Jessen, "Tertiärklima und Mittelgebirgsmorphologie", *Zeitschrift für Erdkunde*, 1938, pp. 36–49. H. Louis, "Rumpflächenproblem, Erosionzyklus und Klimageomorphologie", *Geomorphologische Studien* (*Machatschek Festschrift*), 1956, pp. 9–26; "The Davisian cycle of erosion and climatic geomorphology", *Proc. IGU Regional Conference in Japan* 1957, 1959, pp. 164–6.

[37] Cf. also H. Louis, "Rumpflächenproblem . . ." (*op. cit.*), p. 13.

[38] J. Tricart and A. Cailleux, *op. cit.*, p. 163.

[39] H. Baulig, "Peneplains and pediplains", *Geol. Soc. America Bull.*, vol. 68, 1957, p. 925.

[40] P. Woldstedt, "Die Klimakurve des Tertiärs und Quartärs in Mitteleuropa", *Eiszeitalter und Gegenwart*, Band. 4/5, 1954, pp. 5–9.

[41] J. Büdel, "Grundzüge der klimamorphologischen Entwicklung Frankens", *Würzburg Geogr. Arbeiten*, Heft. 4/5, 1957, p. 35.

[42] J. Büdel, "Grundzüge der klimamorphologischen Entwicklung Frankens" (*op. cit.*), p. 42.

Economic and Political Changes in the Sahara

JOHN I. CLARKE

During the past decade few parts of Africa have escaped brusque political and economic changes: the Sahara is no exception. In area nearly one-quarter of Africa, it stretches from the Atlantic to the Red Sea and is roughly defined to the north and south by the 4-inch isohyets. In this paper examination of the deserts of Egypt and the Sudan is largely excluded.

For centuries the Sahara was almost a void between White Africa and Black Africa, between the large measure of cultural uniformity in the Arab world and the fragmentary diversity of Negro cultures. East–west movement was confined to the desert periphery, and contact between the northern and southern margins was maintained by long and arduous caravan routes whose main purpose was the transport of Negro slaves. During historic times, the indigenous peoples of the entire Sahara have never exceeded 2½ millions, and the vast majority have known only poverty, malnutrition and disease. Under a merciless climate of meagre rainfall, strong winds and extremes of temperature, existence has been possible only by tribal co-operation, ruthlessness and ingenuity. To escape from excessive reliance on the whims of rainfall, the pastoral nomads asserted their superiority over the sedentary peoples either by "protecting" them from external attacks, a species of blackmail, or by importing their own slaves as cultivators. For some caravans they provided camels, especially for the salt caravans of the southern Sahara; from others they exacted tribute, default from which meant a raid, and nomadic survival often depended on the success of such raids. Sometimes the nomads lived on the fat of the land; this was never true for the wretched oasis-dwellers, who, everywhere except in the eastern Sahara, experienced perpetual serfdom. They successfully produced crops only by means of laborious hydrological practices such as the excavation of *foggaras* (e.g. Tademaït), hollows in dunes (Souf) or deep wells (Mzab). Some cultivators were members of heretical religious sects, others belonged to tribal groups which had fled from more powerful invaders. Most suffered from malaria, dysentery and trachoma.

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EARLY EUROPEAN INFLUENCES

At first the European conquests brought few positive changes to this traditional picture of the Sahara. Although the desert was carved up by France, Spain, Italy and Great Britain during the late nineteenth and early twentieth centuries, it was accredited with little economic value. European penetration was very slow, and until after the last war the desert was controlled by a handful of soldiers. The European powers were much more interested in the peripheral regions and in colonizing the moister Mediterranean zone to the north of the desert. European rule brought few benefits to the desert peoples, and there was no effective policy for social and economic advancement in the French, Spanish or Italian Sahara. Several ambitious schemes had more prestige value than utility. Even scientific expeditions were mainly academic and more was known about the anthropology than the environment, partly because it was hazardous to depart from established tracks.

The European powers regarded the Sahara as little more than a romantic waste. It is thus one of the bitter resentments of the peoples of northern Africa that the Europeans established arbitrary political boundaries which now greatly affect the economic development of the newly independent states. With vast uninhabited areas and widely separated nuclei of population, the Sahara knew neither boundaries nor states before the advent of the Europeans. Nomadism and boundaries are irreconcilable. Moreover, Islamic doctrine takes no account of the State, and therefore the Moslem concept of the territory, the area in which the State exercises its sovereignty, naturally differs markedly from the Western concept. It should also be remembered that in Islam there has always been a belief in the indivisibility of Moslem territory as well as in its inherent expansion. Consequently, it is not surprising that the geometrical lines conceived by Europeans with no detailed maps or knowledge of the Sahara should command little respect among the Moslem peoples. All the more so when they lack accurate delineation, as is the case of most Saharan frontiers.

Justifying his African deal with France in 1890, the Marquess of Salisbury remarked that he had allowed the Gallic cock to scratch the sands of the desert. Accordingly, France acquired well over 1½ million square miles of desert which were slowly "pacified" between 1900 and 1935.[1] Pacification was followed by slumber under the administration of army officers, for whom the Sahara has always had a great mystique. The curious feature of the French Sahara was that it was divided up among those parts of the French African Empire which surrounded the desert. The chief reason is found in the directions of conquest.[2] Algeria secured the largest portion, because it was the first French foothold in North Africa, the main base for Saharan conquest and an integral part of France. The Protectorates of Tunisia (1881) and Morocco (1912) gained far less. As the southern Sahara was penetrated from West Africa, it became attached to the northern provinces of French West Africa (Mauritania, Soudan and Niger) and French Equatorial Africa (Chad). All territories of the French Sahara were therefore associated with extra-Saharan sectors, a factor of moment to the new independent states.

Until recently, the main economic effects of French Saharan administration were the suppression of "protection" and raiding, the increase in motor transport leading to the reduction of camel caravans, the greater freedom of oasis-dwellers and the growth in the supply of underground water. Nomads therefore lost several of their former means of livelihood.[3] Some in the northern Sahara also found it more difficult to find summer pastures in the moister Mediterranean zone, the scene of extensive European colonization. By owning date-palms and operating the system of share-cropping, other nomads managed to retain some of their power. On the other hand, the oases became swollen with the debris of impoverished nomadic tribes and with the sedentary peoples who had been saved from early death by the introduction of modern medicine. More people meant more poverty. Despite the constant migration to cities outside the Sahara, where through mutual co-operation the migrants often succeeded in obtaining monopolies of certain occupations (e.g. watchmen, porters, dockers, etc.), the oases experienced chronic maladjustment.

In the far west, the Spanish acquisition of the sparsely populated Rio de Oro, Saguiat al-Hamra and Cape Juby, forming together the Spanish Sahara, was motivated by a dream for the revival of imperialism. Spain never seriously envisaged substantial economic benefits, and, indeed, outside of two or three towns the material effects of its administration were negligible until recently.[4]

Imperialistic aims also instigated the Italian colonization of Libya, but the Italians were mainly interested in the settlement of the two widely separated Mediterranean zones of northern Tripolitania and northern Cyrenaica. The conquest of the enormous desert zone was not achieved until the nineteen-thirties.[5] During the conquest, the Libyan nomads, especially the Senussi of Cyrenaica, endured considerable privations as a result of their resistance to the Italian invaders; and in the short time remaining to them in Libya, the Italians accomplished little to change the faces of the far-flung oases of the Fezzan, Kufra, Jalo and Jarabub. In any case, they had few philanthropic aims about raising the living standards of the native inhabitants. After the last war, the British and French military administrations were primarily concerned with efficiently maintaining the *status quo*.

RECENT POLITICAL CHANGES

On Christmas Eve 1951, Libya became a United Kingdom of just over one million people. The achievement of independence by backward Libya was certainly a stimulus to the wave of nationalism which swept north Africa during the following decade. By the end of 1960 only two Saharan territories were still under European rule, namely Algeria and Spanish Sahara. Libya's success undoubtedly intensified nationalist activity in the Maghreb, the Arabic term for the Atlas lands of Morocco, Algeria and Tunisia, whose peoples have always looked upon Libya as a transit zone between Egypt and themselves. From 1881 the Maghreb was synonymous with French North Africa, and it followed that many Frenchmen found it hard to forgive Britain for its support of Libyan independence. Another stimulus to nationalism was the role of Egypt as the advanced core of the Arab world and the leader of anti-colonialism.

Tunisia and Morocco were the first two territories of French Africa to gain sovereignty (March 1956), partly because of their former protectorate status and partly because they had known some national identity, especially Tunisia, before French occupation.[6] This identity has grown markedly since independence, despite their contrasting régimes. Flanking Algeria on east and west, they have persistently backed the cause of Algerian nationalism, but both are bitter about the restricted nature of their Saharan possessions. Tunisia claims that its thin spear of Saharan territory should be slightly wider. Morocco feels that it should probe much deeper into the Sahara, and is greatly annoyed about the truncation of its zone of Saharan influence, which at times extended as far as Timbuktu and Tuat. Morocco claims that four-fifths of its territory has been removed by France; she demands the regions of Tindouf, Colomb-Béchar, Tuat, Spanish Sahara and Mauritania. Indeed, the claims include all those parts of the western Sahara which are said to be the source zone of Moroccan culture and religion. In reply, France scorns these remote and fragile historical connections, which, it is argued, give no legal right to Saharan lands.[7] France asserts that in 1912 Morocco had no real national feeling, no stable and delineated territory, no organized governmental institutions and no national economic identity. There is the widespread impression that Morocco is merely clamouring for the new Saharan mineral discoveries, to which she has no right. The matter is further aggravated by the fact that no legal document exists to establish the precise line of much of the frontier between southern Morocco and the Algerian Sahara. It coincides with the limit of more or less effective French administration in 1912, at the establishment of the Protectorate. To the French the frontier is "natural" as it follows a clear change in geology, vegetation, customs, language, modes of life and architectural style; to Moroccans this reasoning means little. They are particularly desirous of Spanish Sahara and Mauritania. Yet after giving Cape Juby to Morocco in 1958, Spain seems determined to retain the remainder of its Saharan territory, despite its poverty, geometric shape and sparse population and probably because of its potentiality in oil. As for Mauritania, its independence in November 1960 aroused great indignation in Morocco, and Tunisian support for Mauritanian independence caused an angry quarrel between Morocco and Tunisia.

Along with the French atomic explosions in the Sahara, Mauritania has become one of the recent issues affecting African political groupings. It is interesting to see how 12 former French colonies rallied to support Mauritanian independence at the Brazzaville conference in December 1960. They conflict with the group which met at Casablanca, including the U.A.R., Libya, Ghana, Mali and Senegal. Mali, the former Soudan, is following an individual course. Its federation with Senegal lasted only a few months, and now, like Guinea, it has formed a liaison with Ghana. On the other hand, the republics of Niger and Chad are still associated with southern Algeria in the *Organisation Commune des Régions Sahariennes* (O.C.R.S.). Aware that the administrative fragmentation of the French Sahara would hamper rational economic development, France founded O.C.R.S. in January 1957 in an attempt to integrate plans. In June of that year, an abortive Ministry of the Sahara was created. O.C.R.S. came too late, however, and instead of comprising all the former Saharan territories of France, it is now really effective only in the two *Départements* of southern Algeria (Oasis and Saoura). Conventions of co-operation have been signed with Niger and Chad, but with a number of reservations. The slow acceptance of O.C.R.S. results from rising nationalism and the fear that it may be a Saharan state in disguise, or that it is an attempt to dissociate the Algerian Sahara from the rest of Algeria.

EXPLORATION OF UNDERGROUND RESOURCES

A matter of some surprise to many people is the late exploration of the underground wealth of the Sahara. Several explanations may be proffered, apart from the slow penetration of the Sahara and European interest elsewhere. It is, of course, extremely difficult for scientists and technicians to live and work all the year round in the desert, sometimes 500 miles from the coast. The advent of air-conditioned caravans, specialized Saharan vehicles, the helicopter and other reliable air transport has greatly facilitated large-scale exploration. The war helped to improve techniques of desert travel, and also to demonstrate the value of aerial photography which has become an essential instrument for the geological mapping of the desert. The Sahara was long held to be geologically uninviting to oilmen; there were very few surface shows, and it was thought that the extent of the basement (Fig. 1) of Pre-Cambrian igneous and metamorphic rocks and Pre-Cambrian and early Palaeozoic non-fossiliferous sediments was much greater than it is in reality.[8] One reason for the underestimation of the extent of sedimentary basins in Africa as a whole was undoubtedly the predominance of basement in littoral regions and the limited knowledge of the interior. Furthermore, many of the vast sedimentary basins of the northern Sahara, between the Atlas ranges on the one hand and the Hoggar and Tibesti on the other, are partially masked by large expanses of erg. Modern methods of geophysical prospecting have overcome many of the former difficulties.

THE FRENCH EFFORT IN ALGERIA

Much of the recent political and economic interest in the region follows from the success of the massive French effort to find wealth in the desert. As her colonial empire dwindled and her technical competence and need for energy grew, France met the challenge of the Sahara. For many Frenchmen it became a desert of dreams: dreams of an inland sea in place of the extensive Shotts Melrhir and el Rharsa southeast of Biskra; of the northward diversion of the Niger to the desert basin of Taoudini; of the use of hydrogen bombs to increase the yield of deep wells; of the distillation of sea-water to irrigate the desert; of the widespread production of artificial rain, wind power and solar power; of the use of fossil soil under the surface of reg; of the completion of the Mediterranean–Niger railway; of the construction of trans-Saharan roads; of the discovery of oil, natural gas and minerals. . . . Some of the dreams seem fantastic; all are costly.[9] Many depend on other developments, indeed on the integral development of the Sahara as a whole. It was apparent that the key was underground wealth. The French public were fed with the prospects of the Sahara, and they paid in taxes for its costly exploration. The costs have not yet been recovered, but there is ample evidence of considerable natural resources, though perhaps not as momentous as some of the official literature would have us believe.[10]

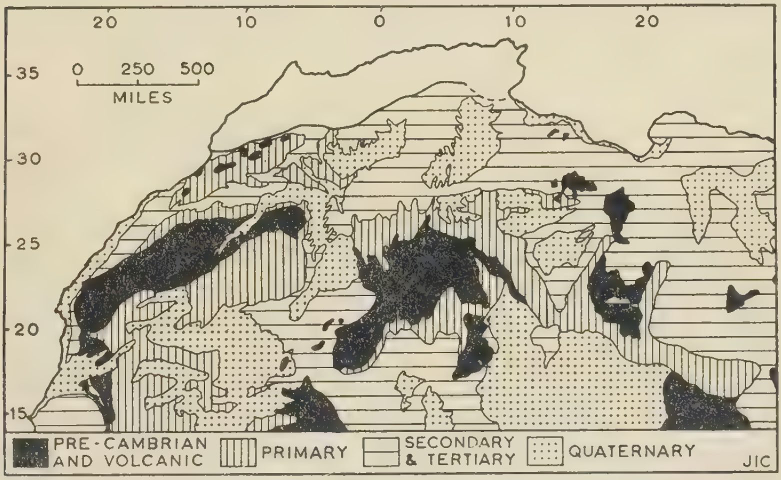

Fig. 1.—Geological outline of the Sahara, after N. Menchikoff, "Les grandes lignes de la géologie saharienne", *Revue de Géographie Physique et de Géologie Dynamique*, Paris, vol. 1, 1957, pp. 37–45.

Water

Successes have been achieved in the discovery of water, minerals, petroleum and natural gas. The vast Secondary and Tertiary basins of the north Sahara, Tanezrouft and the Fezzan have been shown to contain prolific artesian aquifers. The most famous is the *nappe albienne* of Jurassic to Cretaceous age, more appropriately termed the Intercalary Continental. In the north Saharan basin alone this aquifer extends over 230,000 square miles. Estimates of its potential yield vary, but the average flow usable without reducing reserves may be about 25 to 30 cubic metres per second.[11] Other aquifers have been located in the limestones of the Upper Cretaceous and Eocene, and in the Mio-Pliocene, known as the Tertiary Continental. Many oases are now tapping these aquifers, but it would be foolish to expect them to add more than a few tiny patches of green to the desert. Nevertheless, they will be of inestimable value to the exploitation of the other resources of the Sahara, and the establishment of permanent settlements.

Minerals

Much has been heard of the abundance of mineral resources in the French Sahara (see Fig. 2), but despite the massive onslaught of the various and often competing public organizations (*Bureau d'Investissement en Afrique*, *Bureau de Recherches Géologiques et Minières*, *Commissariat à l'Energie Atomique*) the results are disappointing. It is true that a wide variety of ores has been located in diverse parts of the French Sahara, but exploitation is invariably hampered by the insufficient quantities of ore, the remoteness of water or the costs and difficulties of transportation. The last are mainly responsible for the slow progress in the development of the major deposits of iron ore at Fort Gouraud[12] in Mauritania and Gara Djebilet in western Algeria; not merely distances from the Atlantic but also the intransigent attitude of the Spanish government to proposals for railways to cross its Saharan territory. Transportation problems are also instrumental in impeding the exploitation of the copper deposits at Akjoujt in Mauritania, and the manganese ores at Djebel Guettara, 95 miles south of Colomb-Béchar. Moreover, they also limit the production of the Moroccan lead ores of Taouz, 110 miles west of Colomb-Béchar, and the tinstone of the Aïr massif northeast of Agades in the republic of Niger. Even the 350,000 tons of coal per annum produced by the Kenadsa coalfield near Colomb-Béchar are very expensive by the time that they have travelled across the whole Atlas system to the port of Nemours. Most of the deposits mentioned so far have lain within less than 250 miles of the limits of the Sahara. Consider then the transport difficulties in the export of ores from the massifs of the central Sahara. In the Eglab, Hoggar, Tibesti and Aïr, gold, silver, copper, zinc, lead, tin, cobalt, nickel, chromium, molybdenum, wolfram, uranium, thorium, platinum, asbestos and diamonds have all been found, but it is not at present possible to extract and export them commercially.

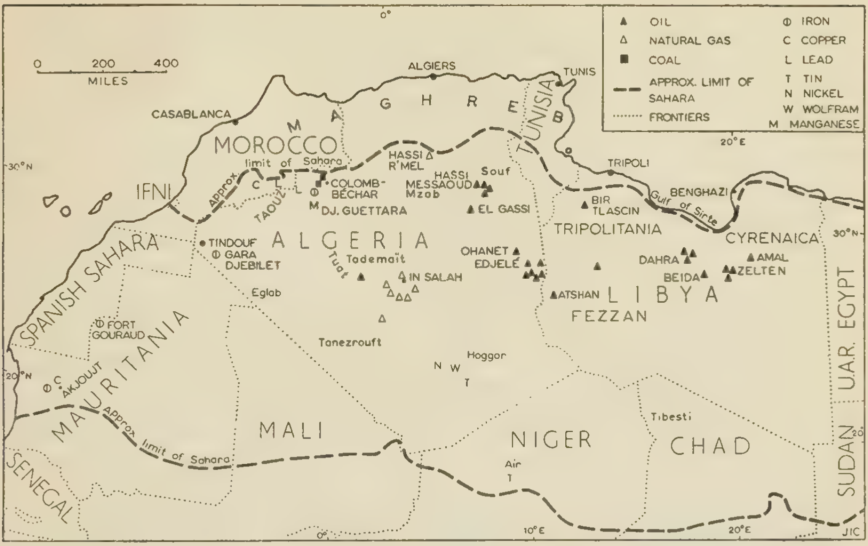

Fig. 2.—Saharan resources, many of which are discoveries of the past decade.

Oil

Fortunately, the French search for oil, which began in 1952, has produced far more worthwhile results.[13] Initially the French State controlled the search through five major companies, in all of which she had dominant or exclusive interests. Now that her own explorations have been successful and the burden of the costly exploitation is bearing heavily upon her, North American, German and Italian companies have been permitted concessions in Algeria, although all have been required to enter into joint agreements with French companies. They are also required to relinquish half of their oil permits after five years—a great stimulus to speed of exploration—and to share their profits from the sale of crude oil with the State on a 50–50 basis.

So far, two main groups of oilfields have been discovered in the northern and eastern parts of the Algerian Sahara, where the main explorations have taken place (Fig. 3). Recently, however, there have been indications of more oil in the western Sahara. The first group is centred on Hassi-Messaoud, 60 miles east-southeast of the oasis of Ouargla. Oil was discovered in 1956 at 11,200 feet below the surface. Exports soon began via a short pipeline to Touggourt and then by railway to the Mediterranean port of Philippeville, but this utterly uneconomic method was replaced in December 1959 by a 400-mile 25-inch pipeline to a new oil terminal at Bougie. The 1960 production of this field was 6½ million tons from 54 producing wells. Early expectations of reserves amounting to 500 million tons may be too high, and it is now realized that the field suffers from variable porosity and permeability. By May 1961, the Hassi Messaoud–Bougie pipeline will also carry oil from El Gassi–El Agreb, a new field about 75 miles south of Hassi Messaoud, to which it will be connected by a 10-inch pipe carrying initially a flow of 500,000 tons per annum. In 1961, the main pipe should carry 10 million tons.

Three hundred miles southeast of Hassi Messaoud, across the Great Eastern Erg, are a group of scattered oilfields situated within a few miles of the Libyan frontier. Edjelé, the first Saharan discovery, had by the end of 1960 over 90 producing wells, though with a meagre average output of 300 barrels per day (cf. Hassi Messaoud field average of 3000 b/d). In the vicinity, Zarzaitine was discovered two years later and is a larger and more productive field, with over 70 producing wells by December 1960. Other fields have been located in the same basin, known as Fort Polignac, at Tiguentourine, El Adeb Larache, Oued Oubarakat, Ouan Taredert, Ouan Taredjeli and Oued Zenani. Productive layers are shallower than at Hassi Messaoud and range from 1300 to 5000 feet deep. At first it was thought that pipeline connection with Hassi Messaoud would be very difficult across the erg, so arrangements were made for the construction of a 450-mile 24-inch pipeline from the desert terminal at In Amenas across Tunisian territory to the new oil port at La Skhirra. This port, north of Gabès, is now capable of receiving tankers of 75,000 tons. The pipe was completed in September 1960 at the cost of the equivalent of £33 million, and the flow was soon at the rate of 7 million tons a year. When the other fields are brought into production and new pumping stations are built, the flow may be doubled.

In 1960, a new field was discovered north of Edjelé at Ohanet. By autumn 1961 it is expected to produce at an annual rate of 1½ million tons from 20 to 25 wells. An interesting point is the agreement of the French government to a proposal to connect Ohanet by pipeline with Hassi Messaoud, 350 miles to the northwest, rather than with In Amenas only 75 miles distant. Two implications are possible: that hopes for the Fort Polignac basin exceed those for the Hassi Messaoud field, or that it is desired to avoid over-dependence on the trans-Tunisian pipeline.

Early estimates of Algerian production spoke of 50 million tons by 1965—a figure which seems unlikely to be attained, though in view of the immense exploration activity it would be foolish to forecast. The target of 20 million tons for 1961 may well be achieved. France is anxious to supply her own oil needs, which are now of the order of 25 million tons a year. This amount seems well within the potential Algerian production, and so French reliance on Middle East supplies and the Suez Canal may be greatly reduced. Stress has been laid on the fact that Bougie is only 410 miles from Marseilles, whereas the head of the Persian Gulf is 4850 miles and the Levant coast 1600 miles from the French port. These facts have naturally coloured the French attitude to Algeria. At the same time, the Algerian nationalists have made no determined attacks on the pipelines; they are well aware of the strength of French military protection as well as of the value of oil to the Algerian economy. Algerian exports have been far too long dominated by wine.

There are complications, of course. In contrast to Persian Gulf oil, for example, Algerian oil is many times more distant from the coast, it is deeper, the oil-bearing rock is less porous, more wells are necessary, production costs are higher, and the crude oil yields a much lower proportion of fuel oil. In the case of Hassi Messaoud, it gives only 20 per cent. However, European demand is primarily for fuel oil, and European refineries are geared to the reception of Middle East oil with a high fuel oil content. Saharan oil is more suitable for the American market, but this market is protected, and there is also severe Venezuelan and Middle East competition. At first, it appeared that France was trying to obtain guaranteed outlets for Algerian crude oil within the European Common Market, but this policy aroused quick opposition from Britain, Italy and the United States. France now takes the view that franc zone oil must be consumed within that zone, and is adjusting her own refineries.

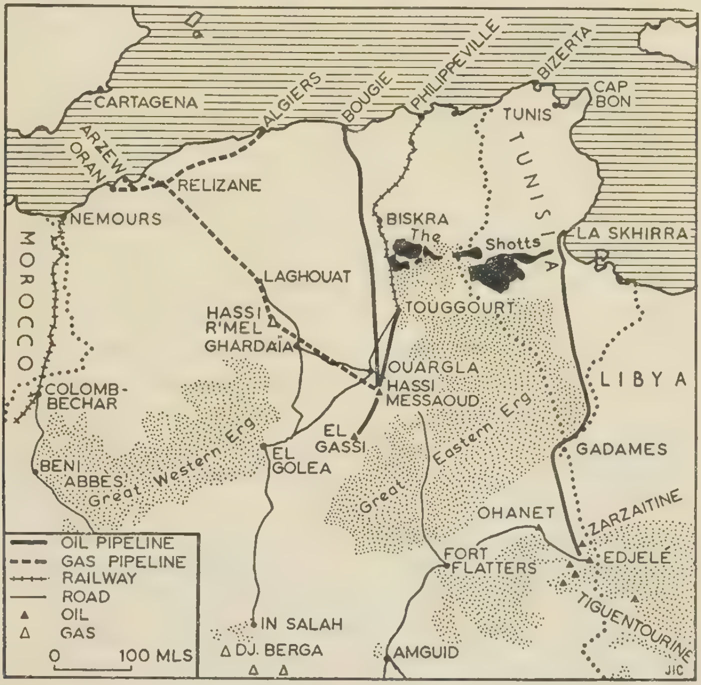

Fig. 3.—Algerian oil and natural gas. Exploitation is made difficult by remoteness and the extent of erg.

Natural gas

Algeria also possesses important natural gas supplies in three separate localities. The first is in the Central Sahara in the vicinity of In Salah, nearly 600 miles from the coast, at Djebel Berga, Djebel Thara and Tibaradine. Distance has so far precluded exploitation. There are also gas supplies at Hassi Messaoud, but the most important deposit was discovered in 1956 at Hassi R'Mel, about 40 miles northwest of Ghardaïa and 280 miles south of Algiers. It is one of the richest deposits in the world, with estimates of recoverable reserves varying between 750,000 and 1,000,000 million cubic metres, the equivalent of 1000 million tons of oil. Many wells have been completed, and a 24-inch pipeline has been constructed from Hassi Messaoud to Relizane and continued as a 20-inch pipe to the coast at Arzew. The start of commercial operations is scheduled for April 1961 at an initial rate of 1½ million cubic metres a day. It is confidently expected that by 1965 the Algerian market alone will consume over three times this amount, about 1500 million cubic metres per annum, and that exports will reach 2000 million cubic metres. Now the problems are those of transporting the gas across the Mediterranean and marketing it in Europe. Three possibilities are available: the use of tankers to carry deep-frozen liquid methane; the extension of the north Algerian gas pipeline to Tunis and the Cap Bon peninsula and then the construction of a submarine duct to serve Sicily and southern Italy; the construction of a longer submarine duct from Arzew to Cartagena, to be continued by a pipeline through Spain to France. A point of consideration is the relative potential consumption of gas by Italy and Spain.

Communications

Much of the success of the French effort would not have been possible without the considerable improvements in communications. The widespread use of air transport in exploration has been followed by a great increase in road transport in the exploitation of the resources. Several of the important north–south axes are being transformed from tracks into roads (Fig. 4): the Oran–Colomb-Béchar–Reggane axis; the Algiers–Laghouat–El Goléa–In Salah axis; and the Biskra–Touggourt–Hassi Messaoud–Fort Flatters axis. There is also an offshoot of the last axis to El Oued and the Souf, and a transverse link between Ghardaïa and Ouargla. Much of the work was necessitated by the wear and tear to Saharan vehicles, despite their huge size and special features.[14] The new roads will also help to revitalize the old settlements of the Sahara, a feature which is also assisted by the employment of labourers in oil companies, by the influx of O.C.R.S. capital, and by emigration to France and the return of remittances.[15]

THE TUNISIAN POSITION

No oil has yet been found in Tunisia. Gulf and Shell abandoned their searches in northern and central Tunisia in 1954 and 1956 respectively. The small Saharan sector remained unexplored until the last few years, but now SEREPT, Rimrock International, Conorada, Mobil and the

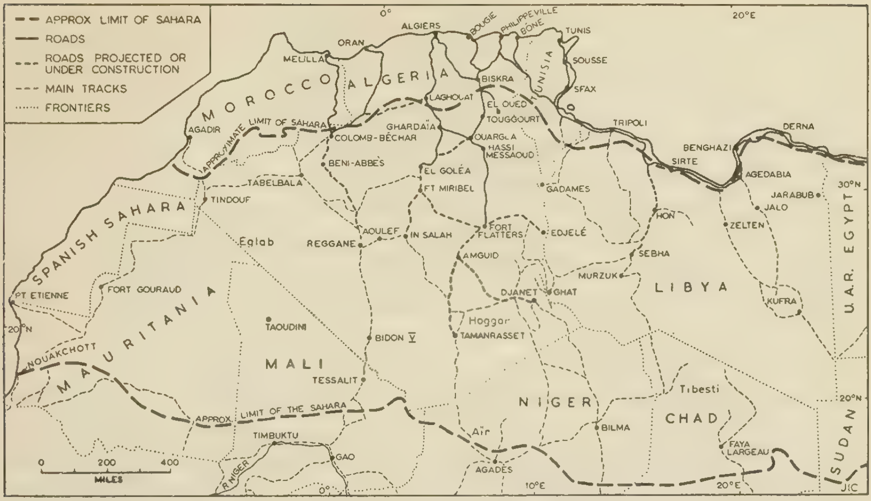

Fig. 4.—Saharan routes. The speed of road construction is rapid, and this map purports to show the pattern in mid-1960.

Italian government-owned ENI are active.[16] The energetic Signor Mattei of ENI has offered to construct at La Skhirra a refinery in which the Tunisian government will have a half share. The refinery will have a capacity of about 1 million tons per annum, twice the present Tunisian consumption of petroleum products.

Tunisia's position in the middle of the North African coast is comparable to that of Lebanon in the Levant. Both these small countries have individual cultures and some significant economic activities, and are now important oil transit zones. They both have surprisingly important international roles, and are good listening posts for Middle Eastern and North African affairs. The analogy must not be carried too far, but both Lebanon and Tunisia have experienced the impact of French civilization, follow independent but pro-Western policies, and are not willing to be subdued by the strength of the U.A.R. The Tunisian President, Habib Bourguiba, is a firm protagonist for the unity of the Maghreb, but in recent years growing differences of opinion among the North African leaders endanger such unity. The discovery of oil in the Tunisian Sahara would give the country's economy, excessively dependent on agriculture, a great fillip, and help her to sustain her independence.

THE LIBYAN OIL RUSH

Most of the vast country of Libya is in the Sahara. Although this has been the prime cause for centuries of nomadism and poverty, it is now becoming the cause of some satisfaction, as Libya is in the throes of an oil rush. Since independence, Libya has survived only because of the financial aid of Britain and the United States in return for military installations. Over 58 per cent of the 1959–60 budget was subsidized by foreign aid. Agricultural possibilities are limited to the Mediterranean fringes of northern Tripolitania and northern Cyrenaica where the bulk of the population is concentrated. Apparently almost devoid of natural resources, Libya became a laboratory for the under-developed lands, with a standing United Nations Mission, a United States Operations Mission and other foreign technical assistance.[17] In these conditions, Libya has been able to maintain her expensive administrative structure of a United Kingdom with four governments, one federal and three provincial for Tripolitania, Cyrenaica and the Fezzan. She has also remained detached from the ferment of Arab politics; but the discovery of large quantities of oil is bringing Libya into brutal contact with the modern world.

The Edjelé discoveries persuaded the Libyan government to welcome foreign oil companies. Now there are more than 20 concessionaires, including all the major groups. Their land and marine concessions measure over 430,000 square miles. In 1960 alone the total expenditure of the oil companies was the equivalent of about £55 million, and at the end of 1960 34 drilling rigs and 42 seismic parties were operating. During the period 1958–60, 57 productive wells were drilled in thirteen separate concession areas, with a total potential production of over 105,000 barrels per day. Speed of exploration is again partly explained by the petroleum law, which stipulates that concessionaires must surrender one-quarter of their areas at the end of 5 years, a further quarter after 8 years, and that within 10 years of the initial grant the concessions in the northern Zones I and II (see Fig. 5) must be further reduced to one-third of their original size and those in the southern Zones III and IV to one-quarter. These terms and the 50–50 division of profits have attracted keen competition for concessions, and now British, French, North American, Dutch, German and Italian companies are represented. It is surely ironical that only now is Italy making a search for oil in Libya.

At least three fields of commercial importance have been discovered already and all are in the area to the south of the Gulf of Sirte: the Esso field at Zelten, the Oasis field at Dahra and the Amoseas field at Beida. Zelten and Dahra are both being connected by pipelines with new oil terminals on the Gulf of Sirte, which at last is proving an advantage to the Libyan economy. Exports from Marsa el Brega, the port for Zelten, will begin this year. Other important finds have been made in several places in the Fezzan and in western Tripolitania, but there is no talk of development.

Libyan "proven" reserves do not yet match those of Algeria, but hardly a month passes without a new oil-bearing well. It is not surprising that France has been disconcerted by the Libyan finds, which are mostly shallower and nearer the coast than the Algerian oilfields, and are cut off neither by erg nor by mountain ranges. Zelten I and II gushed forth 17,500 and 15,000 barrels per day respectively, but it would seem that the Libyan fields are smaller and thinner than the major fields of the Middle East, and that like Algerian oil, Libyan oil is also light.

Libya's position with respect to the Middle East and Maghreb is interesting. For long a "no-man's land" between the two, Libya now shows more inclinations towards the Middle East and is more in favour of Nasser than Bourguiba. At one time, a coup d'état seemed likely against the monarchy and for an association with the U.A.R. It now seems less imminent, as the oil successes have given Libyans the feeling that they can manage their own affairs. Libya is a keen member of the Arab League and anxious to co-operate with Arab countries, but how will Libyan oil exports to Europe affect her relations with the Middle East oil-producing countries? At present these countries do not seem over-worried. They believe that Libya can be relied upon to co-operate rather than compete. In any case, they feel that the total production of Saharan fields will not immediately reduce West European demands

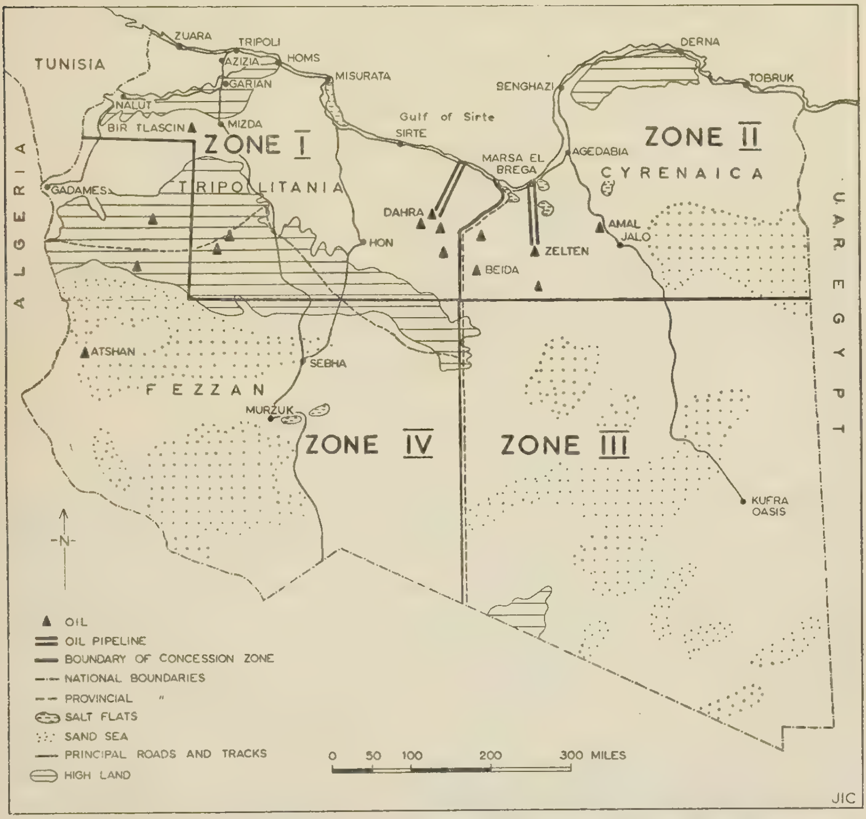

Fig. 5.—Libyan oil. The main concentration of oilfields is in the Sirte lowlands on either side of the boundary between Tripolitania and Cyrenaica. The main exploration activity is in the two northern zones.

for Middle East oil, and that the amounts exported will be determined by the major international oil companies, who will not be anxious to change their marketing arrangements quickly. (However, the Middle East oil-producing countries realize that they cannot afford to be complacent, and are now contemplating the growing Asian markets.)

Matters of internal significance are dominated by the problem of the best utilization of the oil revenues and the comparative size of the oil finds in the three provinces. The second matter may have considerable influence on the future of the kingdom, for the federation has not been altogether happy. The more advanced pro-Egyptian Tripolitanians have had little respect for the Senussi monarchy, of Cyrenaican origin, and the death of the ageing King Idris may well bring a change of régime. As American and British influence wanes, possible political links with the U.A.R. cannot be overlooked. On the other hand, the growing importance of the Sirte oil discoveries may offset any contemplated split between the provinces. Located in the vicinity of the boundary between Tripolitania and Cyrenaica, the new fields may form a new nucleus around which real national unity could be forged. Moreover, oil in the Fezzan may raise the status of this enormous province which has only 56,000 people (1954) and no road yet linking it to the coast. It seems evident that Libyan oil will be of great political influence in North Africa during the coming years.

THE OIL SEARCH ELSEWHERE

Oil discoveries have been confined so far to the Algerian and Libyan Sahara, but they have greatly stimulated exploration elsewhere in the northern Sahara. Interest has revived in the Western Desert of Egypt, although in 1958 four American companies withdrew after drilling nine holes and spending \$26½ million on the search. Now applications have been made for new concession blocks, in spite of more restrictive terms than operate in Libya. In each concession area 25 per cent of the permits must be relinquished after only three years, and 50 per cent at the end of the sixth year. Furthermore, although 50–50 profit sharing is again in force, upon discovery of oil an Arab company must be formed for the exploitation of the field. The U.A.R. is, of course, very conscious of the imperialist nature of former relationships between oil companies and the Middle Eastern states.

In Morocco there is a similar feeling, and whilst the 50–50 profit-sharing system has been adopted, the system favours direct state partnership in new concessions. But Morocco is bitter that she is unable to pursue the search further south along the coast, for the Spanish Sahara is particularly attractive territory for oil exploration. Apart from the southern sector of basement rock, the Spaniards have an area which is geologically inviting, relatively flat and sand-free, near the coast and near the European and North American markets. Moreover, the local labour shortage could be solved by bringing in

Canary Islanders. When in 1959 Spain opened the doors to the participation of foreign capital in oil exploration and exploitation, 162 applications were made for 35 blocks, despite the stipulations that permits may not be given to companies in which more than one-third of the voting power is held by foreign governments, and that the oil must first be used to supply the Spanish market. Nine of the ten successful applicants are North American companies in co-operation with Spanish companies, and the other permit-holder has offered a licence for manufacturing petrochemicals.

In Mauritania oil exploration is still in the early stages, although there is hope for the coastal zone and the Taoudini basin. Two American companies, Cities Service and Continental Oil are associated with the French SAP and EURAFREP. This new desert republic, whose population is largely nomadic, urgently needs economic developments. Farming is almost confined to the Senegal valley in the south, and exports comprise only small quantities of fish, salt and livestock. Although France is spending money on the construction of the new capital of Nouakchott and on other schemes, hopes for modernity depend on oil discoveries and the export of the Fort Gouraud iron ores. Without these, it is difficult to foresee a stable future for this poverty-stricken country.

Along the southern margins of the Sahara, where large sedimentary basins exist, there is some reconnaissance and prospecting for oil in Mali, Niger and Sudan, but none yet in Chad. The southern Sahara is, of course, much further from the sea than the northern Sahara, and accordingly less accessible. Intensive exploration is therefore likely to be delayed for a year or two until the true potentialities of the northern Sahara are revealed. In these conditions, the southern republics of Mali, Niger and Chad are likely to experience great difficulties during the next few years, and it is not surprising that one has opted for links with Ghana and the other two with O.C.R.S.

A NEW OIL PROVINCE

There is little doubt that a new oil province is emerging which stretches in a broad belt across the northern Sahara. The main effort has been concentrated in the Algerian Sahara, where conditions of exploitation are perhaps the most difficult because of the distance from the sea. It is possible that the main successes may be elsewhere. Oil will be of great significance to the economies of the various countries; not merely to the sparsely populated almost entirely desert countries, such as Mauritania, Spanish Sahara and Libya, but also to those countries with densely populated areas outside of the Sahara, such as Morocco, Algeria, Tunisia and Egypt. All have inadequate agricultural and industrial resources to feed their rapidly expanding populations. It is too early to measure the extent or the importance of this new oil province, but it will certainly give much greater economic and political significance to the Sahara, and may counter the concentration of strategic values in the Middle East. In view of this, it will be fascinating to watch the political alignments in Africa, to see how much they reflect colonial traditions, racial consciousness and national self-interest. We should expect further changes in the map of northern Africa. Furthermore, it will be interesting to see how African dependence on European markets affects relationships between the two continents. Above all, it is to be hoped that the new oil wealth will be widely disseminated amongst the people of North Africa, in particular those who have so long endured the trials and tribulations of a desert existence.

THE FUTURE?

The Sahara will no longer remain an anthropological museum. One should expect a further decline of nomadism, a form of economy which is too parasitic and too unreliable to accord with the conditions of modern life. Already the Libyan government, for example, is trying to settle the nomads, in order to facilitate their education as well as to dispose of tribalism and impose a new administrative structure. It is no easy problem, without causing massive rural depopulation and a further increase in the ranks of the urban unemployed; but it is imperative that the nomad should be given a new deal in the very near future. Two methods are possible, both dependent on the improved utilization of water resources. The first is the abolition of large-scale nomadism by the rationalization of livestock farming and the establishment of permanent foci: reliable watering-places, forage reserves and stable administrative, social and economic amenities (offices, schools, cinemas, garages, slaughter-houses, etc.). Forage reserves could be greatly increased by plantations of spineless cacti, planned afforestation and the multiplication of irrigation projects for forage production. Progress in rearing could also be achieved by specialization in aims and breeds as well as improvements in techniques and marketing. The latter will be assisted by rapid transport on the new roads. This first method may achieve more success than the second which implies the transformation of nomads into cultivators, a process to which true nomads rarely take kindly. Semi-nomads of the Saharan fringes have occasionally been successfully settled, but schemes for peasant colonization using people with no traditions of cultivation have sometimes proved to be uneconomic.[18]

As for the share-croppers of the oases, it is obvious that they will not long endure their plight. The French officers in the Algerian Sahara have often tried to restrain them from leaving for northern towns and France, fearing the shaky oasis economy would entirely collapse. This is a real danger, despite the growing local market for vegetables, fruit and other oasis products. Yet without a complete reorganization of the tenurial system, substantial improvements in methods of irrigation and cultivation along with extensions of irrigated areas, one can see little hope for Saharan agriculture as it is to-day. Perhaps the future lies in the thermo-nuclear distillation of sea-water for the irrigation of coastal belts.

Some see the future of many Saharan people in manufacturing, construction and services of all kinds. Who knows what the next decade will bring? It is salutary to remember that ten years ago the only independent African country with Saharan territory was Egypt, and that nowhere else in the desert had anyone looked for oil.

REFERENCES

[1] The best general geographies of the French Sahara are R. Capot-Rey, *Le Sahara Français*, Paris, 1953, and B. Verlet, *Le Sahara*, Paris, 1958.

[2] See E. F. Gautier, *La Conquête du Sahara*, Paris, 1935, and H. P. Eydoux, *L'Exploration du Sahara*, Paris, 1938.

[3] L. Cabot Briggs, *Tribes of the Sahara*, Princeton, 1960, and in particular Blaudin de Thé, *Essai de Bibliographie du Sahara Français et des Régions Avoisinantes*, Paris, 1960, and the varied studies in *Travaux de l'Institut de Recherches Sahariennes*, Alger.

[4] The basic text is E. and F. Hernández-Pacheco, *et al.*, *El Sahara Español. Estudio geologico, geografico y botanico*, Madrid, Inst. Estud. Afr., 1949.

[5] R. W. Hill, *A Bibliography of Libya*, Department of Geography, Durham Colleges in the University of Durham, Research papers series no. 1, 1959, lists over 2000 works.

[6] Two valuable texts are N. Barbour (ed.), *A Survey of North West Africa*, London, 1959, and L. Hahn, *North Africa: Nationalism to Nationhood*, Washington, 1960.

[7] For the French viewpoint see M-R. Thomas, *Sahara et Communauté*, Paris, 1960, pp. 9–97; for a different view see N. Barbour, *op. cit.*, pp. 61–4.

[8] The main features of the geology are found in R. Furon, *Le Sahara: Géologie, Ressources Minérales, Mise en Valeur*, Paris, 1957, and N. Menchikoff, "Les grandes lignes de la géologie saharienne", *Revue de Géographie Physique et de Géologie Dynamique*, Paris, vol. 1, 1957, pp. 37–45.

[9] A readable résumé is given in G. Gerster, *Sahara*, London, 1960.

[10] For example, the brochures of the *Service de l'Information du Gouvernement général de L'Algérie*: "Le Sahara"; "Le Sahara algérien"; "Les territoires du sud de l'Algérie: l'oeuvre accomplie". For a more balanced approach, see "Le Sahara", *Science et Vie*, Numéro hors série, Juin, 1958.

[11] J. Dubief and A. Cornet, "Le problème de l'eau conditionne l'essor saharien", *Science et Vie*, *op. cit.*, pp. 50–61.

[12] R. J. Harrison Church, "Problems and development of the dry zone of West Africa", *Geographical Journal*, vol. 127, pt. 2, 1961.

[13] With reference to petroleum developments in the Sahara, the author acknowledges the invaluability of the numerous articles and notes in the *Petroleum Press Service*, London (monthly), as well as the July issue each year of the *Bulletin of the American Association of Petroleum Geologists*, Tulsa.

[14] For an excellent volume on Saharan transport see "Infrastructure et transports au Sahara", *Revue Générale des Routes et des Aérodromes*, Numéro special, Juin 1959, no. 329.

[15] The Souf is an example. C. Bataillon, "Ressources et vie de relation du Sahara: l'exemple du Souf", *Annales de Géographie*, vol. 69, 1960, pp. 493–507.

[16] Of considerable value are the various publications of the *Secrétariat d'Etat à l'Information du Gouvernement Tunisien*: "Le Sahara", 1959; "Tunisia", 1957; "La Tunisie au Travail", 1960.

[17] The problems of Libyan development are examined in the report of the International Bank for Reconstruction and Development, *The Economic Development of Libya*, Baltimore, 1960; United Nations Doc. ST/TAA/K/Libya/3, *The Economic and Social Development of Libya*, 1953; and A. N. Lockwood, "Libya—building a desert economy", *International Conciliation*, no. 512, March 1957, pp. 313–78.

[8] See, for example, K. S. McLachlan, "The Wadi Caam Project: its social and economic aspects" in S. G. Willimott and J. I. Clarke (eds.), *Field Studies in Libya*, Department of Geography, Durham Colleges in the University of Durham, Research papers series no. 4, 1960, pp. 70–6.

Changing Industrial Patterns of New England

R. C. ESTALL

NOT INFREQUENTLY the mature industrial region may find itself confronted by new national and international conditions of demand and supply that render its existing industrial structure incapable of maintaining previous levels of employment and prosperity. Certain industries in which the region may once have been pre-eminent may suffer decline in the face of severe competition from more recently industrialized areas. This decline of old-established industry, with its serious consequences for the people of the region, tends to be more dramatic and to receive greater attention than the incipient stages in the development of new products and processes, and current literature often tends to leave an unjust impression of stagnation and general decline. But major industrial regions die as hard as their traditions. Their capacity for regeneration in the face of declining staple industries must not be under-rated, for they offer a variety of incentives to continued industrial activity.

An important example of such industrial regeneration is to be seen in the changing industrial patterns of New England. In older studies of this region we find that textiles and leather almost monopolize the industrial treatment. And rightly so. It could truly be said that "the story of the New England cotton industry is the story of the industrialization of America".[1] The drastic decline of the textile industry's fortunes in this century, however, has often tended to dominate discussion of the New England economy. Less attention has been focused upon the growth of newer industries, especially in the metal-working group, which have contributed to the emergence of a new structure of industrial employment, especially during and since the second world war. This article examines recent trends in industrial employment and production in the region; illustrates and discusses the salient features of New England's distinctive industrial economy; analyses briefly the structure of industry in the larger industrial areas; and concludes with a short general assessment of the attractions and shortcomings of the New England region for industrial enterprise.

THE CHANGING INDUSTRIAL STRUCTURE 1939–1954[2]

In many respects the industrial fortunes of New England are comparable

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with those of old England. Both made an early start in the industrial race; both developed a high level of dependence on industries (especially textiles) in which they possessed no enduring advantage; both experienced inevitable decline in relative and even absolute terms as newer centres began to compete in their established industries. In New England the effects of this external pressure were enhanced in many respects by restrictive and rigid attitudes on the part of both workers and management and by the lack of important material resources in the region, especially as direct use of water power (albeit inadequate itself in New England) was replaced by steam. New England had passed through its period of supremacy by the time of the first world war. Between 1919 and 1939 the number of manufacturing firms decreased by 18 per cent and the number of manufacturing workers fell by 26 per cent. The dismal fortunes of the textile industry dominate the canvas, employment falling by about 36 per cent. The contraction of employment in the leather industry was less spectacular but nevertheless very serious. The various metal-working industries, electrical machinery only excepted, also experienced sharp declines in employment. Only in the apparel (i.e. clothing) industries and in printing and publishing did employment increase between the two world wars.

Between 1939 and 1954, however, the region made a strong recovery, and the numbers employed in manufacturing industry increased by about 25 per cent, returning approximately to the 1919 overall figure. The most notable feature of this renewed industrial development has been the rapid increase in the part played by four metal-working industries (non-electrical machinery, electrical machinery, fabricated metal products and transport equipment manufacture), with the two machinery groups outstanding. The production of industrial and household machinery and ball and roller bearings figures prominently in the expansion of non-electrical machinery manufacture, while in the electrical machinery group a variety of electrical industrial apparatus and "communications equipment" (including wireless products, electronic tubes and telephone and telegraph equipment) plays a major part. Concurrently with the war-time and post-war rise of these two industry groups to positions of major importance came a further drastic decline in the textile industry's fortunes, and a less drastic but highly important contraction in the leather industry.

The changed positions of the four leading industries are shown in Table I and the fundamental changes in overall industrial structure are brought out more emphatically in Table II. The decline of the textile industry's proportion both of total employment and of value added by manufacture* is remarkable; the leather industry has a much smaller rate of relative decline. Indeed, since about 1947 it has practically held its own.

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* Value added by manufacture is obtained by subtracting the cost of materials of all kinds and of contract work from the value of the shipments from each establishment. The Bureau of the Census considers it to be the best comparative measure available.

It will be noted, however, that these four industrial groups together provided a smaller fraction of total industrial employment and value added in 1954 than in 1939 (Table II). This suggests an expansion of other industries apart from the two machinery groups and thus an increased diversification of the industrial structure. The most significant growth was again in trades concerned in some way with metal working. The manufacturers of transport equipment increased their employment very rapidly, almost entirely in the manufacture of aircraft engines and aircraft parts. The fabricated metal product industries increased their capacity in many branches, including the manufacture of bolts, nuts and rivets, metal stamping, plating and polishing and sheet metal, structural and ornamental work. Significant gains were also made by the instruments industries, especially in scientific and mechanical measuring instruments, and in medical and surgical appliances, but the old-established watch and clock manufacturing industry has declined.

Table I

NEW ENGLAND—ESTABLISHMENTS, EMPLOYMENT AND VALUE ADDED BY MANUFACTURE. FOUR LEADING INDUSTRIES, 1939 AND 1954

	Establishments		*Employment (thousands)*		*Value Added ($ million)*	
	1939	1954	1939	1954	1939	1954
Textile Mills Products ..	1,253	1,383	281	168	462	844
Leather and Leather Products	1,043	1,161	117	110	174	477
Non-electrical Machinery ..	916	2,425	105	179	288	1,312
Electrical Machinery ..	196	603	46	121	126	885
TOTAL for all Manufacturing Industry in New England	15,200	22,006	1,122	1,403	2,414	8,954

Source: See Reference 2.

Table II

ESTABLISHMENTS, EMPLOYMENT AND VALUE ADDED BY MANUFACTURE IN FOUR LEADING INDUSTRIES (EXPRESSED AS A PERCENTAGE OF NEW ENGLAND TOTALS FOR ALL INDUSTRY)

	Establishments Per cent of New England Total		*Employment Per cent of New England Total*		*Value Added Per cent of New England Total*	
	1939	1954	1939	1954	1939	1954
Textile Mills	8·2	6·3	25·0	11·9	19·1	9·4
Leather and Leather Products	6·7	5·3	10·4	7·8	7·4	5·3
Machinery (non-electrical) ..	6·0	11·0	9·3	12·8	11·9	14·6
Electrical Machinery ..	1·3	2·7	4·1	8·6	5·3	9·9
TOTAL for all Four Industry Groups	22·2	25·3	48·8	41·1	43·7	39·2

Source: See Reference 2.

Most emphasis has been placed so far on the increased importance of the industries connected with metal working in various ways because total employment in these industries was practically doubled over the 1939/54 period. Economists regard this change in the balance of industrial employment from what are termed "non-durable goods" industries (which include textiles and leather) to "durable goods" industries (which include all the metal-working groups) as of great importance. The classification of industry groups into these two categories broadly separates types of industry that respond in different ways to the fluctuations of the trade cycle. A "balanced" industrial region will not, ideally, be over-dependent upon one category, but will have its industrial capacity distributed among industries of both durable and non-durable product types. In addition, the requirements for advanced labour skills and advanced industrial techniques vary markedly as between certain major industries in the two categories. With some important exceptions the non-durable goods category contains more of that type of industry whose techniques and labour requirements are simpler, and which are thus more readily established in relatively immature industrial environments. (The two categories are listed in Table III.)

Historically, New England displayed a very high level of economic dependence upon two non-durable goods industries in which competition from newly industrialized areas was bound to be severe, and this has had serious repercussions in this century. Although this state of imbalance is being corrected, we should not under-estimate the continuing importance of non-durable goods industries in the region. Their position has been dominated by changes in the textiles and leather industries, but other non-durable goods industries have expanded in employment and, even more significantly, in terms of value added by manufacture. Among these industries, the apparel, pulp and paper, printing and publishing and the chemical products groups may be distinguished.

It is clear, then, that the present industrial structure of the region bears little resemblance to that of even 20 years ago. The general position with regard to employment in all identified industrial groups in 1956 is given in Table III. This shows that employment in durable goods industries is approaching parity with that in non-durable goods industries as the textile industry continues its secular decline and the metal-working groups continue to advance. These changes vary quite substantially in their geographical incidence, however, and the improved industrial conditions and prospects that they imply are not common to all industrial centres in the region.

NEW ENGLAND'S DISTINCTIVE INDUSTRIAL STRUCTURE

One important feature contributing to the recognition of New England as a separate geographical region is its distinctive economy.

Manufacturing industry is of much greater importance here than it is in the U.S.A. as a whole. Thus, while New England had about 5·7 per cent of the total civilian labour force in the U.S.A. in 1956, it had about 8·9 per cent of the total employment in manufacturing industry. Agriculture and the mineral extraction industries are relatively weakly represented here, and the tertiary occupations, though growing, also provide a smaller proportion of total employment in New England than they do nationally. In addition to its greater relative importance, manufacturing activity in New England also presents a rather distinctive pattern. The region still has a comparatively heavy stake in non-durable goods manufacture and in certain static or declining industries, while some very important industries are extremely weakly represented here.

Table III

INDUSTRIAL EMPLOYMENT IN NEW ENGLAND AND U.S.A. 1956 (MONTHLY AVERAGES)

	U.S.A.	*New England*	*New England as per cent of U.S.A.*
	(thousands)		
Durable Goods:			
Primary Metal Industries	1,310	58	4·4
Fabricated Metal Industries	1,116	106	9·5
Non-electrical Machinery	1,724	186	10·7
Electrical Machinery	1,212	141	11·5
Transport Equipment	1,795	106	5·8
Instruments and Related Products	339	48	14·2
Lumber and Wood Products	724	43	5·8
Furniture and Fixtures	376	22	5·7
Stone, Clay and Glass Products	569	24	4·2
Ordnance and Accessories	131	15	11·4
Durable Goods Total*	9,295	747	8·0
Non-durable Goods:			
Food and Kindred Products	1,578	69	4·3
Tobacco Manufactures	101	0·9	0·8
Textile Mill Products	1,051	168	16·0
Apparel and Related Products	1,212	88	7·2
Pulp, Paper and Products	568	75	13·2
Printing and Publishing	854	63	7·3
Chemicals and Products	835	32	3·9
Rubber Products	276	47	10·7
Leather and Leather Products	374	112	29·9
Petroleum and Coal Products	253	3	1·3
Miscellaneous Manufacture	496	98	19·8
Non-durable Goods Total*	7,598	756	9·9
All Manufacturing Industry:			
Durable and Non-durable Goods	16,893	1,504	8·9

* Totals out because of rounding.

Source: *New England Business Review*, December 1957. Computed from Bureau of Labour Statistics data. The procedure for collecting these statistics differ slightly from that of the Bureau of the Census on which Tables I and II are based.

These points are illustrated in Table III, which presents New England's employment in every industry group as a percentage of total national employment in that group. Since the region has 8·9 per cent of the total national employment in manufacturing industry, it may be suggested that in any industry in which New England has more than about 13 per cent of the national total, there is a degree of concentration in the region that requires some explanation. Conversely, wherever New England has less than about 5 per cent of the national total, the industry concerned is weakly represented. Figure 1 shows how the structure of industrial employment in New England differs from that in the U.S.A. as a whole.

Among the non-durable goods industries *textile manufacture* clearly remains of considerable importance, though with only 16 per cent of all textile mill workers in the country the degree of concentration in New England is lower than might be expected. This is especially true of cotton goods manufacture. Thus, of a national total of 20·5 million active cotton spindles in 1956, New England possessed only 2·1 million. Especially since the war, however, the loss of textile mill capacity in New England has begun seriously to affect the woollens and worsteds branch of the industry, too. The requirements for highly skilled labour and the proximity of the New England woollen towns to the very large market of the northeast and to the huge apparel industry of New York preserved New England as the nation's chief centre of the woollen industry. Now, however, the region has begun to lose its grip. In 1949 it still possessed about 53 per cent of all woollen spindles and some 70 per cent of all worsted spindles in place in the U.S.A. By 1956 these proportions had fallen to approximately 47 per cent and 44 per cent respectively.[3]

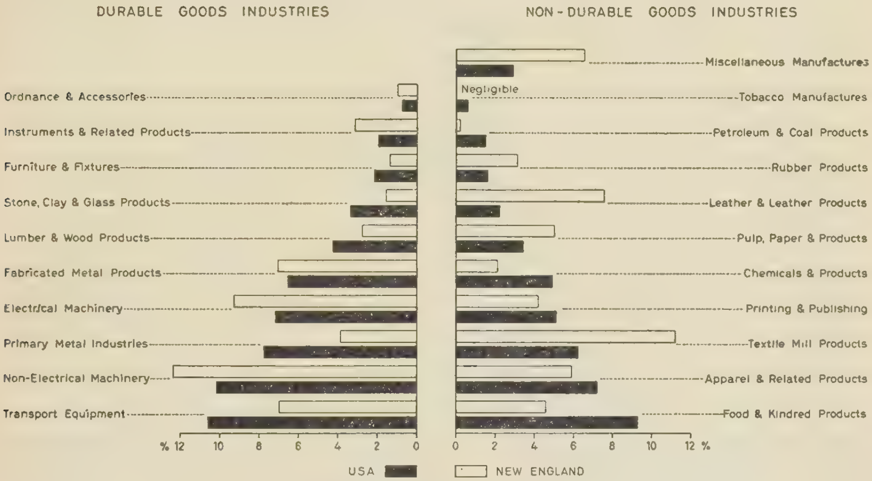

Fig. 1.—Distribution of industrial employment, New England and U.S.A., 1956. Source: see Table III.

The textile industry has not yet reached the end of its secular decline in New England, but the contraction of employment will probably proceed, as in the past, at a faster rate than that of output, measured in terms of value added. The slower decline in production is explained by changes in the type and quality of yarns and cloths produced, and by increased labour productivity achieved through the introduction of new techniques and other innovations. Further, the finishing section of the industry, in which value added in manufacture is relatively high, has not experienced the same serious decline in employment as other sections and has, in fact, substantially increased its total value added by manufacture since the war.

By contrast, the contraction of the *leather and leather product* industry appears to have halted, leaving an outstanding concentration in the region (see Fig. 1). Despite the long years of contraction and the emergence of other important centres of production, about 30 per cent of all leather industry workers remain in New England. This industry is chiefly concerned with footwear manufacture, in which New England enjoys a high reputation. The greater relative importance of the *rubber product* industries in the region is also in part due to the concentration here of footwear manufacture, but tyres and rubber items for the electrical industries appear among the many other rubber products.

The *pulp, paper and products group* is also more important in the industrial structure of New England than in the country as a whole. This industrial group is growing very rapidly in several regions of the country, but New England may well obtain an increasing share of new capacity in future years.[4] A rising demand for pulp is expected to exert great pressure on soft wood supplies and this will increase the importance of pulpable hardwood. New England possesses large stands of such hardwoods and will, in such circumstances, become more attractive to the pulp and paper industry. This is a future prospect, however, and at present many New England paper mills obtain their pulp from Canada, the southern States of the U.S.A. and Scandinavia. The attractions of the region for paper making, chiefly the proximity of the enormous market in north-eastern U.S.A. and the ample and pure water supplies, are seriously offset by the fact that fuel and power costs are higher in New England than in the chief competing centres elsewhere. This is a serious disadvantage, for this industry is a large energy consumer.

In sharp contrast to such non-durable goods industries in which New England has a greater concentration of employment than the country as a whole are those in which employment in the region lags well behind the national proportion. Chief among these are the *food products* and *chemicals and products* industries. The reasons for their relative weakness here are readily understood. Many food product industries are necessarily located close to their raw material supplies. In New England, however, agricultural conditions are relatively difficult, and the range of products that would attract and support a large food canning, preserving or processing industry is limited. Apart, then, from those branches of the industry that must be located close to the consumer (such as baking, confectionery manufacture and soft-drink bottling), the food products industries are not strongly represented here, and this industry group as a whole is steadily losing ground in relative importance.

The chemicals industry is a rather different case. Fig. 1 shows that it is relatively unimportant in the employment structure of the region but, between 1939 and 1954, employment in this industry group increased at about twice the average rate for the region. This expansion owes much to the chemical research work (especially in plastics materials, drugs and medicines) that is performed here, for this attracts chemical manufacturing establishments. It is worth noting that the value added by manufacture in this industry group is very high per head of the labour force and that, consequently, its importance is not adequately reflected in employment figures. Nevertheless, despite its steady growth, the region's chemical product industry remains small, its stature being seriously limited by raw material and power supply deficiencies.

Among the durable goods industries there are again some notable differences between the structure of employment in New England and that of the U.S.A. as a whole (Fig. 1). The two machinery groups both rank higher in New England than they do nationally. The differences are not large enough to be really significant, but they serve to emphasize the attractions of New England for this type of industry. The *non-electrical machinery* group in New England produces a wide variety of end products, among which machines for metal grinding and cutting, and machinery for the textile, leather and paper industries may be mentioned. Such industries gain from proximity to a major market for their product, and are therefore well established here. The fact that the textile machine market has largely migrated from the region had not become significantly reflected in the location of this industry in 1954, but textile machine making capacity now seems to be growing in the southeast states.

In relation to the *electrical machinery* group, the importance of research and new product development facilities in New England must be emphasized. Electronics research and training facilities are considerable here, especially around Boston, and this attracts new enterprises which develop the new products and processes discovered in the laboratories. It was estimated that, in 1955, at least half of all employees in electronics establishments in New England were working on products developed by research since 1950.[5]

The electrical products industry also has much to commend it to textile mill operators who wish to diversify their industrial interests and to use their available floor space and staffs more fully. The market for electrical goods is expanding rapidly, and the manufacture of such electrical components as switches, plugs and clips does not require heavy initial capital investment. Furthermore, small productive units can operate effectively and economically. For such reasons, the vacant floors of old textile mills are occasionally to be found occupied by small enterprises in the electrical product industry. There is a variety of excellent reasons, therefore, why this industry group has become the fastest growing group in New England and bids fair to become the region's leading industry. Perhaps more than any other industrial group it employs advanced managerial, labour and technical skills in the manufacture of products requiring relatively small inputs of raw materials and power, and having a high value per unit of weight. It is for this type of product that the New England environment is most suited.

Although the great importance of the *transport equipment* industry has been emphasized, Fig. 1 indicates that this group is much less significant in New England than it is nationally. This is a misleading impression, however, arising out of the industry classification. This group includes the manufacture of motor vehicles, ships, locomotives and aircraft, and it is in the aircraft industry that expansion of capacity in New England has been most spectacular. More than a quarter of all persons employed in the U.S.A. in the manufacture of aircraft engines are in New England, while the manufacture of various parts, and especially propellor units, also shows a heavy concentration in the region. The large supplies of skilled labour and the multitude of sub-contractors that these branches of the aircraft industry require, are found in a special concentration in southern New England, and especially in Connecticut. Airframe construction and final assembly thrive best in a different type of location, however, and are not important in New England.

The New England ship-building industry is also notable, even by national standards, since about 12 per cent of the country's total ship-building workers are employed in New England yards. Tankers and naval vessels, including atomic submarines, are constructed. The apparently weak position of the transport equipment industry in New England as shown in Fig. 1 is due entirely to the relative weakness here of the motor vehicle industry.

Intimately connected with the strong growth of the durable goods industries is the *instruments and related products* industry group. An increased demand for measuring and controlling devices has resulted from atomic research and development, the requirements of aircraft, ships and the electronics industry and from the recent expansion of guided missile production.

Among the durable goods industries are also certain products and processes that play a smaller part in the New England economy than they do nationally. A very important disparity is in the *primary metal* group (Fig. 1). This group includes the smelting of metals, especially iron and steel, and in this process New England suffers from substantial locational disadvantages. The region lacks the essential raw materials;

it suffers substantially in relative transport costs from its peripheral location; it lacks a sufficiently large market for the output of a modern integrated iron and steel works. It is not surprising, therefore, that the iron and steel industry in New England, always small, has declined substantially *since* 1956, the date for Table 3 and Fig. 1. The region's largest steelworks, at Worcester, Massachusetts, has been dismantled, and its only blast furnace, at Everett, Massachusetts, has been shut down. Only two small electric steel furnaces remain. This is a most serious deficiency, and the relative industrial position and prospects of New England are probably affected more adversely by its inadequacies in this respect than by any other considerations.

The primary metal group also includes non-ferrous metal rolling and drawing, and wire-drawing plant. These processes account for most of the present employment in this industry group in New England, and have close connections with the machinery and electrical product industries.

Other durable goods industries in which New England is relatively weak include the lumber and wood products industries and stone, clay and glass product manufacture. The reasons are similar to those mentioned in the case of the primary metal industries.

INDUSTRIAL PATTERNS AND TRENDS WITHIN THE REGION

New England's industries remain overwhelmingly in the south of the region, and especially in Massachusetts and Connecticut (Table IV). The pattern of employment in each state is shown in Fig. 2, and the significant changes in selected industry groups between 1939 and 1954 are given for each state in Table V. The use of value added by manufacture provides a good complementary picture to that of numbers employed, and Fig. 3 gives this measure for important industries in 1939 and 1954. Both Figs. 2 and 3 indicate the diversity of industrial capacity in New England at the present time and, together with Table V, illustrate the changing fortunes of various industries in each state.

The leading industrial areas in the region can be defined as those Standard Metropolitan Areas of the U.S. Census* in which over 40,000 persons are employed in manufacturing industry. The nine qualifying areas in New England provided precisely two-thirds of total industrial employment in Massachusetts, Connecticut and Rhode Island in 1954, compared with 59 per cent in 1939. Over this period all of these areas, except Providence, increased their industrial employment by more than the average proportion for the three states as a whole, i.e. by more than 27 per cent.

The *Boston Area* (280,000 industrial employees†) is the largest, and has its manufacturing interests widely spread (see Fig. 4). The electrical machinery industry is outstanding in its importance and rate of growth, the attractions of the area including, as we have seen, the status of Boston as a leading centre of electronics research and the steady flow into the labour market here of skilled technicians. The growth of employment in this industry has much more than offset the decline of textiles and leather products in the area. Leading products include electronic tubes, transistors, radio and telephone equipment and electrical industrial apparatus. The large non-electrical machinery industry produces machinery for the textile, leather, pulp and paper, and other industries. Together the two machinery groups provide a quarter both of total employment and of total value added by manufacture in the area.

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* The Standard Metropolitan Area is considered to be an integrated economic and social unit, with a "large volume" of daily communication between the central city (which has a population of 50,000 or above) and the outlying parts of the area. Such areas, with over 40,000 persons in manufacturing industry, are the basis of Fig. 4.

† Numbers of employees in manufacturing industry quoted for this and subsequent Areas are for 1954.

Table IV

RELATIVE POSITIONS OF STATES. SELECTED CRITERIA 1954

	Employment in Manufacturing (Per cent)	*Value Added by Manufacturing (Per cent)*	*Electricity Sales to Industry* (Per cent)*	*Per Capita Income* (1955) *(Dollars)*
Massachusetts	47·5	47·8	49·4	2,097
Connecticut	29·1	31·7	26·0	2,499
Rhode Island	8·2	7·6	8·1	1,957
Maine	6·8	5·9	9·2	1,593
New Hampshire ..	5·3	4·4	4·9	1,732
Vermont	2·4	2·4	2·2	1,535
New England Totals ..	1·4 (mill.)	8·95 ($ mill.)	8·35 (mill. kWh)	2,087 ($ average)

* Establishments with annual purchases 180,000 kWh or above.

Source: See Reference 2.

Table V

EMPLOYMENT CHANGES + OR – IN THOUSANDS, 1939–1954
SELECTED INDUSTRIES AND OVERALL

	Textiles	*Leather*	*Apparel*	*Pulp and Paper*	*Machinery*	*Electrical Machinery*
Massachusetts	–61	–7	+18	+6·1	+33	+50
Connecticut	–14	*	–4·5	+3·0	+30	+16
Rhode Island	–28	*	+1·5	*	+2·5	+1·0
Maine	–4·5	+1·9	+1·7	+4·2	*	*
New Hampshire ..	–2·7	–1·4	*	+1·3	+3·6	+6·6
Vermont	–2·8	*	+1·5	*	+4·1	N.A.
New England Overall	–113	–7·0	+18	+16	+74	+74

	Transport Equipment	*Fabricated Metal*	*Instruments*	*Primary Metal*	*All Industries*
Massachusetts	+12	+12	+6·1	+5·4	+118
Connecticut	+53	+6	+4·7	*	+126
Rhode Island	+1·0	+1·7	*	+2·8	–1
Maine	+1·0	+1·3	*	*	+14
New Hampshire	N.A.	*	N.A.	*	+14
Vermont	N.A.	*	N.A.	*	+10
New England Overall ..	+67	+22	+13	+8·5	+280

N.A. = Suitable statistics not available. * = Below 1,000. Total out because of rounding.
Source: See Reference 2.

Other industries provide a wide diversity of industrial employment. The unusual prominence of the food products industries reflects, among other things, the requirements of a large metropolitan population (over 2·3 million) for bakery products, "pop" and "candy". But there are many large industries here, and the textile mills assume a very minor position.*

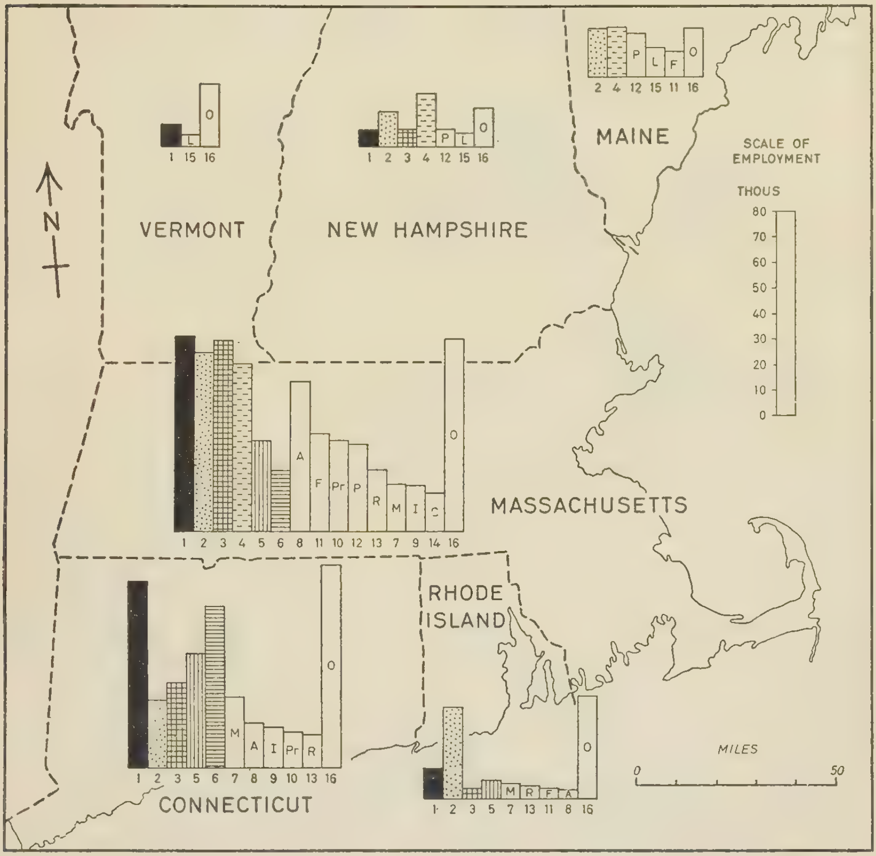

Fig. 2.—Industrial employment by States 1954. For Massachusetts and Connecticut, industry groups employing 10,000 or more are separately identified. For other States industry groups employing 4000 or more are identified. New England's six leading industries are shaded. Source: see reference 2.
1. Machinery (non-electrical). 2. Textile mill products. 3. Electrical machinery. 4. Leather and leather products. 5. Fabricated metal products. 6. Transport equipment. 7. Primary metal products. 8. Apparel and related products. 9. Instruments and related products. 10. Printing and publishing. 11. Food and kindred products. 12. Pulp, paper and products. 13. Rubber products. 14. Chemicals and products. 15. Lumber and wood products. 16. Other manufacturing: all industries not separately identified in each State.

A similar degree of diversity, but embracing a different combination of industries, is found in the *New Haven Area* (47,000 employees). The

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* The attraction of new enterprises to sites on a new motorway encircling Boston is discussed in G. Manners's article in *Geography*, vol. xlv, November 1960, pp. 276–85.

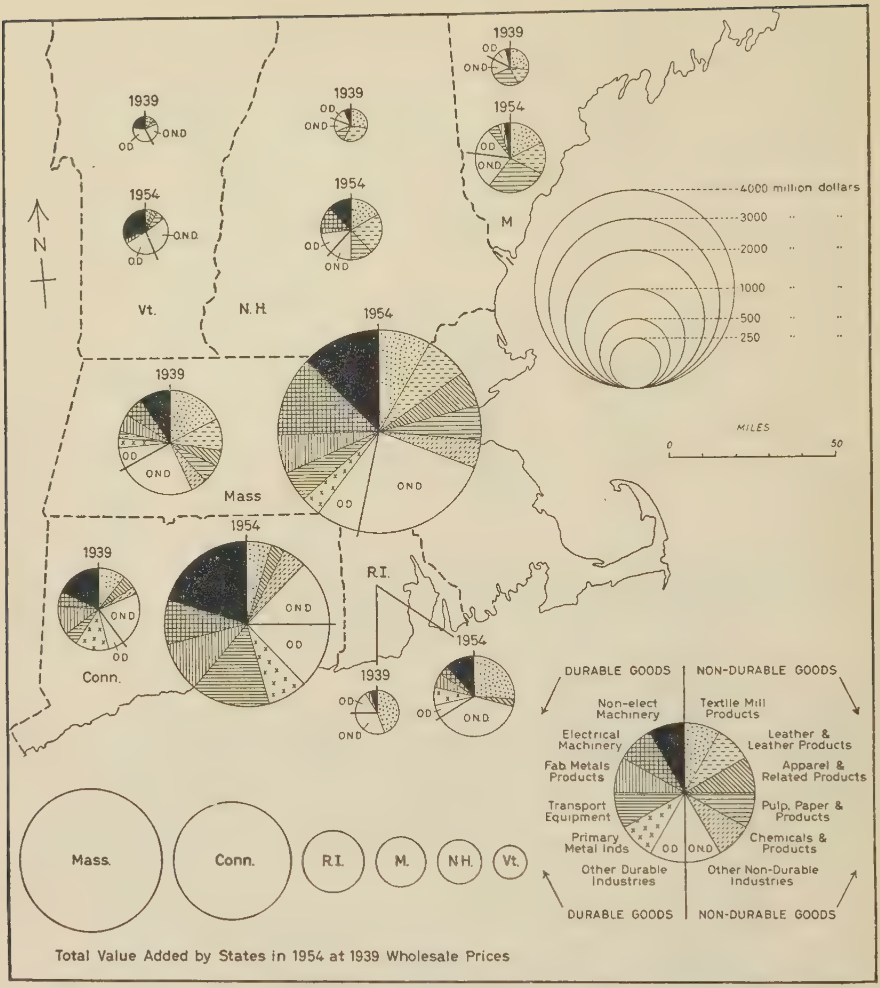

Fig. 3.—Value added by manufacture by States, 1939 and 1954. The "Other durable" and "Other non-durable" categories include all industries not separately identified in each State. Source: see reference 2.

two largest groups, apparel and aircraft engines and parts, employ under one-fifth of the area's total industrial labour. New Haven has its eggs in many baskets—with textiles and leather as notable exceptions.

The *Springfield-Holyoke Area* (74,000 employees) also has its industrial potential fairly evenly distributed among durable and non-durable product industries, but while its non-durable product interests are extremely varied, its output of durable goods is dominated by non-electrical machinery, especially refrigeration machinery. Among its non-durable products the area is rightly noted for its high-quality paper and its woollen and silk mills, though the latter follow the usual trend of decline.

The six remaining industrial areas identified in Fig. 4 can be separated from those just mentioned by reason of the tendency for their industrial capacity to be relatively specialized in either durable or non-durable products. Only the *Providence Area* (130,000 employees), however, continues to show a marked specialization in non-durable goods industries. It is therefore significant that this is the only one of the nine main industrial areas that failed to increase its relative share of industrial employment between 1939 and 1954.* Alone among the nine areas Providence has textile mill products holding the leading position, despite a long-continued and serious decline. Woollens and worsteds and textile finishing are the leading branches of the industry, of which only the finishing section is maintaining its position—as it is in the region as a whole.

In line with the normal trend in New England, however, durable goods industries have increased in relative importance in the Providence Area since 1939. Industrial machinery, metal stamping and coating and wire drawing are prominent. Here, too, special mention must be made of the jewellery and silverware trades which employ, in the Providence Area, almost 30 per cent of the total employed by these trades in the whole country, a remarkable concentration. In the *Census of Manufactures*, these trades are included in a "Miscellaneous Industry" category which, on consideration, has been allocated en bloc to the non-durable goods industries. Thus Fig. 4 includes the jewellery and silverware workers in the "O.N.D." segment.

The remaining areas all tend to be specialized in durable goods manufacture. The largest is the *Hartford Area* (76,000 employees), whose degree of specialization in two industry groups manufacturing durable products is outstanding, amounting to 70 per cent of total industrial employment in 1954 (Fig. 4). The area, with its skilled labour and specialist plants, is an ideal location for the manufacture of aircraft engines and propellor units, but the change in government defence policy in the U.S.A. since 1954 has had some serious consequences for the aircraft industry. The large non-electrical machinery industry here produces mainly office machinery, especially typewriters and dictating machines, and metal-working machinery.

An even greater reliance on durable goods industries occurs in the *New Britain–Bristol Area* (44,000 employees) where two industry groups again, fabricated metal products and non-electrical machinery, provide about 60 per cent of total industrial employment. It is not without reason that New Britain is known as "Hardware City", and it still produces as wide a range of products, though not the identical selection, as that so graphically recounted by Smith and Phillips.[6] It still possesses about 6 per cent of all persons employed in the U.S.A. in the manufacture of cutlery, hand tools and hardware. In the non-electrical machinery group, metal-working machinery and bearings are important products, while the manufacture of instruments is growing—except for the long-established clock industry. The amazingly small role of non-durable goods industries here is indicated by the fact that it was not possible to identify even one such industry in Fig. 4.

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* It may be noted that in the shorter period from 1947 to 1954 only Boston, Hartford and New Haven increased their manufacturing labour force. But the 1954 Census was taken in the trough of a recession, whereas business conditions were more buoyant in 1947. Such features naturally affect the situation. Even so, only Providence shows a really serious decrease of employment between 1947 and 1954 (about 24,000 jobs) which is obviously more attributable to structural decline than to cyclical fluctuation.

The *Bridgeport Area* (65,000 employees) is only slightly less specialized in durable goods manufacture than Hartford, but its interests are spread over a wider range of durable products, as Fig. 4 shows. Electrical machinery manufacture was, in 1954, stronger here than in any other industrial area in Connecticut, but the largest group in terms of employment was non-electrical machinery (especially metal-working machinery), whilst the manufacture of aircraft engines and parts also employed a large number. There is a small electric steel furnace here, but wire-drawing is much more important in the primary metal group.

The *Waterbury Area* (42,000 employees) was unique in New England in 1954, because of the leading position of the primary metal industry group, in which employment and production is almost entirely in non-ferrous metal rolling and drawing. A relatively large concentration of employment here in the manufacture of buttons and buckles and similar products is included in the O.N.D. category of Fig. 4.

Finally, the *Worcester Area* (50,000 employees), though still rather specialized in durable goods industries, has a significant number employed in the old New England staples of textiles (especially woollens and worsteds) and shoes. But most employment is in various metal-working trades, and industrial machinery (for the metal-working and textile industries chiefly) is of importance. The relatively large employment in the primary metal group has declined since 1954, with the dismantling of the local steelworks.

CONCLUSION

The fundamental changes in the industrial environment of the New England region are clearly indicated in a few broad statistics for two years, 1919 and 1956. In both years the number of workers in manufacturing industries approximated to 1·5 million, but while in 1919 40 per cent of these were in textile mills and leather product factories, in 1956 just under 19 per cent were so employed. Various metal-working trades have been important in the region for very many years, and especially in Connecticut, but their relative position has advanced greatly at the same time as textiles and leather have declined. The four main metal-working industrial groups (non-electrical and electrical machinery, fabricated metal products and transport equipment) employed 22 per cent of the total in 1919 and 36 per cent in 1956.

The region as a whole has been prosperous throughout the post-war years, and this renewed prosperity is largely due to its bigger stake in new industries and new products. But not all industrial centres have shared sufficiently in this new growth, and some retain an unhealthily large proportion of their total employment in declining trades. Among the largest industrial centres only Providence, as we have seen, falls in this category, but it is also true of certain smaller industrial centres, some of which have no small place in the industrial history of the region.

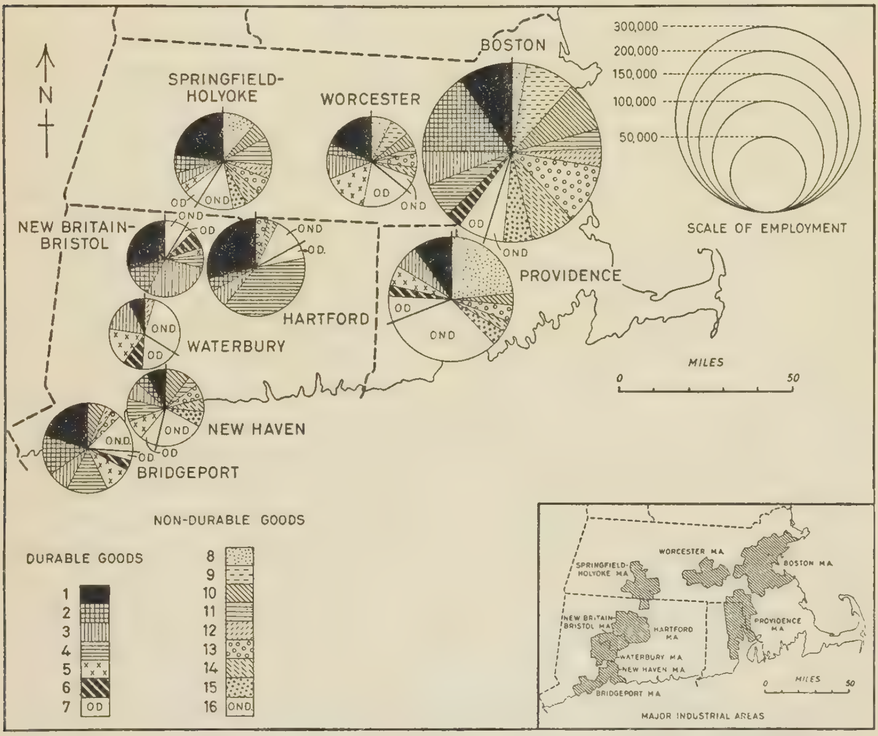

Fig. 4.—Leading industrial areas, 1954. (Standard Metropolitan Areas with 40,000 or more manufacturing employees).
1. Machinery (non-electrical). 2. Electrical machinery. 3. Fabricated metal products. 4. Transport equipment. 5. Primary metal industries. 6. Instruments and related products. 7. All unidentified durable goods. 8. Textile mill products. 9. Leather and leather products. 10. Apparel and related products. 11. Pulp, paper and products. 12. Chemicals and products. 13. Food and kindred products. 14. Printing and publishing. 15. Rubber products. 16. All unidentified non-durable goods. Source: U.S. Census of Manufactures, 1954.

In the northeast of Massachusetts, for example, at Lowell and Lawrence on the famous Merrimac River, there has been a drastic decline in textile mill employment which has brought about serious long-term unemployment problems that remain unsolved. The condition of Lawrence is especially serious. With only a small influx of new industrial capacity to compensate for the decimation of the textile industry, which once gave employment to about three-quarters of the industrial labour force, the total employed in manufacturing industry fell from some 30,000 to 13,000 between 1947 and 1954. The ratio of unemployed to employed persons here is amongst the highest in northeast U.S.A. Similar problems face New Bedford and Fall River in the south of Massachusetts where, again, they reflect the dreary fortunes of the textile interests. Other centres of localized unemployment occur elsewhere, and notably in Brockton, which has been affected by the tendency of the New England shoe industry to migrate northwards, and in Pittsfield, where the most serious losses have again been in textile mill employment.

The continued existence of these problem localities is in part due to the immobility of textile mill workers, both between areas and between jobs,[7] but the incidence of unemployment in the old specialist textile centres must no doubt be lowered by the high *daily* mobility of many American workers. It seems unlikely that there will be any large-scale influx of new industries into the Lowell's and Lawrence's of New England to take advantage of the huge areas of vacant industrial floor space. In general, buildings constructed for the textile industry are unattractive or unsuited to modern industrial needs. It is therefore small advantage for these areas to possess this vacant floor space, even though it may be offered at comparatively low rents. The revivification of these areas will depend on other steps taken to improve their attractions to industrialists. Indeed, the situation is very similar to that in the U.K., where pockets of relatively high unemployment still exist in a generally prosperous community. A significant difference, however, is that in the U.K., government assistance is being given, sometimes vigorously, to these localities. In the U.S.A. no comparable legislation has yet been enacted.

It has been emphasized, however, that these pockets of high unemployment and industrial difficulty occur in an environment of industrial advance and general prosperity, periods of cyclical fluctuation excepted. Some influences that have favoured the renewal of industrial growth in the region may be suggested. The traditions of industrial employment and the availability of labour skills is a very favourable feature of the environment. The quality of labour is undoubtedly affected by the large number of institutes of higher education in the region, and by the steady output of technicians trained in many modern trades. The region is also an important centre of industrial research, especially in electronics, chemicals and in the application of nuclear energy—all of which are expanding in importance. In 1955, 30 per cent of the total value added by manufacture in New England was in products developed since the second world war.[8] As a high income centre (per capita income is some 9 per cent above the national average) the region is attractive to many market-oriented consumer goods producers. Good sites and essential services are also readily available to prospective concerns. Capital loans are made available, and the attractions of various centres are listed, advertised and enhanced, by the energetic activities of many development organizations which operate at all levels, from the regional down to the local. As part of their programme these organizations sometimes also build factories in promising locations, in advance of the location decision of a firm. The immediate availability of new, and well-designed, factory space can occasionally be an important element in a location decision. New England's position on the east coast, with Boston as its major port, and its relatively easy access to the New York area may also have certain advantages to offer. Finally, the very existence of a high degree of industrial development in the region is an asset; for geographical momentum can be an important feature in the location of industry.

On the other hand, however, the region's peripheral location is a serious disadvantage, affecting as it does the transport situation to and from important internal market areas and material sources. Relatively high transport costs are therefore a serious handicap to industry. The lack of important resources, with timber (to some extent) and water as exceptions, raises the cost of raw material and fuel supplies, a feature which is reflected in the industrial structure in an important way. Fuel costs in New England are higher than in any other industrialized area in the U.S.A. The cost of electricity, for example, is about 15 per cent above the national average, and local hydro-electric stations can supply only a small fraction of the region's total needs. Imported fuel costs, with significant local variations, about one-and-a-half times the average for U.S.A. as a whole. Yet, despite such high costs, fuel and power represent a *lower* proportion of total costs for New England industries than they do for industry in the U.S.A. as a whole. The large, and important, fuel-consuming industries can play only a small part in the industrial structure here. This places the region in a relatively disadvantageous position vis-à-vis its competitors in a variety of products. An especially serious deficiency, as we have noted, is the inability of the environment to support a modern integrated iron and steel works, by proximity to which many industries gain substantial cost advantages.

Among other adverse features of New England's position in attracting new industries at the present time we must include certain unfavourable reputations. Firstly, there is the belief that labour costs are relatively high in the region and are, furthermore, seriously affected by rigid and difficult labour attitudes and by a high degree of union activity. In fact, however, New England is no longer a relatively high-wage area in many industries. If pay packets tend to be higher in New England than in some other regions of the country it is more likely to be the result of higher productivity than of wage rate differentials. Further, although New England has its share of labour–management troubles, available statistics do not support the contention that industrial relations are now any worse here than in other parts of the country. Thus, over the inter-censal peroid 1947–54 New England, with about 9 per cent of the total U.S.A. manufacturing labour force, had about 4·6 per cent of total man-days lost due to labour–management disputes. Another adverse reputation held by New England is as an area of high state and local taxation. This is not a simple problem to pronounce upon in a single sentence. State and local taxes are certainly high—especially in Massachusetts, whose reputation in this respect tends to reflect upon the region as a whole—but some students of this problem maintain that the services provided are good, and that the tax structure is sound and fair. Be this as it may, the rumour and the reputation is calculated to have some deterrent effect upon prospective industrialists.

In its industrial environment, therefore, New England is delicately balanced between forces that on the one hand discourage and on the other encourage new industrial development. It is clear from the foregoing assessment of the new industrial structure that the environment has proved attractive to a large amount of new enterprise during and following the second world war. Whatever its future, New England has opened a new chapter in its industrial history.

REFERENCES

[1] C. F. Ware, *The Early New England Cotton Manufacture*, Cambridge, Mass., 1931, p. 3.

[2] Note on statistical sources: the chief source of detailed material is the *Census of Manufactures* taken by the U.S. Department of Commerce. The relevant census years for this study are 1939, 1947 and 1954. From 1949 onwards an *Annual Survey of Manufactures* has been compiled by the Department of Commerce for each non-census year. These are based on a sample survey and are much less detailed in coverage than the census, but from them one may ascertain the direction of broad trends in the manufacturing economy. The census coverage and presentation varies slightly over the census years 1939, 1947 and 1954, but the relevant material for New England has been compiled and made comparable by the Federal Reserve Bank of Boston and published by them in the *New England Economic Almanac* 1957. This almanac is the source of material presented in Tables I, II, IV and V, and in Figs. 2 and 3.

[3] *Statistical Abstract of the United States*, U.S. Dept. of Commerce, 1951 and 1958.

[4] Federal Reserve Bank of Boston, *Business Review*, May 1956.

[5] *Ibid.*, April 1956.

[6] J. R. Smith and M. O. Phillips, *North America*, New York, 1942, p. 101.

[7] See W. H. Miernyk, "Labour Mobility and Regional Growth", *Economic Geography*, vol. 31, October 1955, p. 32.

[8] Federal Reserve Bank of Boston, *Business Review*, July 1958.

The Location of Nuclear Power Stations in the United Kingdom

P. R. MOUNFIELD

IT IS NOW POSSIBLE to outline the geographical pattern of nuclear power generation which is evolving in the United Kingdom and to assess the relative importance of the factors involved in the choice of locations for the nuclear stations. Before discussing these topics it is appropriate to consider the part that nuclear energy is intended to play in the country's power supply plans.

THE RÔLE OF NUCLEAR POWER

The initial Government programme for nuclear power was announced in the White Paper of February, 1955.[1] Twelve nuclear power stations were envisaged, generating between them 2000 MW of electricity by 1965. In 1957 a revised programme was published under which it was proposed that 5000–6000 MW of nuclear power should be realized by 1965.[2] The planned increase of 3000–4000 MW will not necessarily involve a proportionate increase in the number of nuclear power stations, because of current improvements in design and technique. Due to these technical advances the Central Electricity Generating Board is now in a position to build stations of larger generating capacity than was at first envisaged. Furthermore, the increase need not mean that twelve new sites will have to be found, because it may be possible to build two power stations on some sites.[3] In June 1960, the plans for nuclear power were again revised, the 1965 target being re-scheduled for the period 1966–68.[4]

Table I
TOTAL INLAND FUEL CONSUMPTION IN THE UNITED KINGDOM 1913–1959[5]
(Million tons of coal equivalent)

Year	*Total Fuel Consumption*
1913	190·9
1937	198·3
1947	200·7
1957	246·6
1958	248·1
1959	225·9

Several considerations are involved in explanation of the alterations to the 1955 programme. The 1957 proposal to increase nuclear

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generating capacity was prompted by fear of a shortage of conventional fuels for electricity production. As can be seen from Table I, the increase in the yearly total fuel consumption between 1947 and 1958 was much more rapid than it had been from 1913 to 1947.

At the beginning of 1958 it was estimated that by 1965 the demand would have risen to 300 million tons of coal equivalent and to 360 million tons by 1975.[6]

Table II

ELECTRICITY DEMAND AND GENERATING CAPACITY 1920–1959/60[7]

Year	*Sales to Consumers (million units)*	*Installed Capacity of Generating Plant at end of year (megawatts)*
1920	3,240	2,070
1930	8,166	6,240
1938	18,373	8,500
1947/48	32,669	11,680
1957/58	72,661	24,320
1958/59	81,472	25,409
1959/60	89,449	27,611

A substantial part of the increase between 1947 and 1958 was accounted for by the rapidly growing demand for electricity. The coal consumed at power stations increased from 26 million tons in 1948 to 45 million tons in 1958. Since 1920, the demand for electricity has approximately doubled every ten years but the greatest absolute increase has taken place since 1947. To meet the increase, extra generating plant with a total capacity of nearly 16,000 MW has been installed.

With regard to the future, a fairly conservative estimate is that demand will continue to increase over the next fifteen years at about 7 per cent compound each year.[8]

Hitherto the U.K. has relied mainly upon coal for the generation of electricity but in the period 1954–57 it was thought that, after a few years, the fuel requirements of the power stations would exceed the amounts of British coal likely to be available, as estimated by the National Coal Board.[9] In 1956 the Coal Board stated, "Even in the long term the problems of over-production for the coal industry can scarcely arise".[10] By 1957 it was thought that some 10 million tons, or nearly 20 per cent, of the coal or coal equivalent needed for electricity generation by 1960–1 would not be available from home sources and that by 1965–66 the shortage might be 15 million tons, or nearly 25 per cent of the power industry's total fuel requirements.[11]

Nuclear power was adopted as the long-term answer to the problem. In 1957 it was planned to provide 20 to 25 per cent of total electricity output from nuclear stations by 1965–66,[12] bringing about a saving of 15 million tons of coal per annum.[13] Because oil has to be imported, this fuel was regarded as important in helping to bridge the transitional period during which nuclear power was being developed rather than something upon which the country should rely for a large proportion of its power. This attitude was strengthened by the Suez crisis.

However, as can be seen from the figures in Table I, there was an appreciable drop in fuel consumption in 1959. The coal situation had begun to change towards the end of 1957. A modest depression in industry reduced the demand for coal; at the same time increased efficiency in the use of coal began to make itself felt. Most important of all, there was an increase in the use of oil at the expense of coal. As a result, the Coal Board substantially increased its estimates of coal available for electricity generation[14] but the decision to build nuclear power stations for commercial purposes had already been implemented.

Thus the revision of the nuclear power programme announced in 1960 can be interpreted as a reflection of the changed circumstances of fuel supply; but this is only part of the explanation. Since 1955 there has been a considerable increase in the efficiency of conventional plant and this has served to widen the already large gap between the cost of nuclear and ordinary thermal power. It now seems likely that, even by 1970, the cost of electricity from an early atomic plant will be at least 25 per cent higher than from a good conventional station.[15] Moreover, the rising cost of money has made nuclear power seem less attractive at the present time. Because atomic plants involve higher capital outlays than conventional coal- or oil-fired plants, the increase in the interest rate has worked against nuclear power. It is now estimated that by the end of 1964 the nuclear proportion of total output *capacity* will not exceed 5·2 per cent.[16]

THE LOCATION OF THE NUCLEAR POWER STATIONS

Fig. 1 shows the distribution of the first nuclear stations together with proposed sites. The conventional capacity installed or planned in the period 1955–65 is also shown on this map. It is apparent that the advent of nuclear power is bringing about some modification of the geographical pattern of electricity generation. In contrast to most of the new conventional plants, all the nuclear stations will be a considerable distance from the coalfields and some will also be a long way from the load centres which they are intended primarily to serve.

Factors affecting the general location of the nuclear stations

In terms of the cost of the electricity which nuclear stations produce, initial capital costs are at the moment so high that the power generated is not competitive with coal- or oil-generated power.

The extent to which the capital costs of nuclear stations can be reduced below their present level is one of the principal determinants of the degree to which nuclear power stations can be built economically *instead of* coal-fired stations. The other determinant is the load factor at which the nuclear stations will operate. The capital element in the cost per kilowatt hour generated is inversely proportional to the load

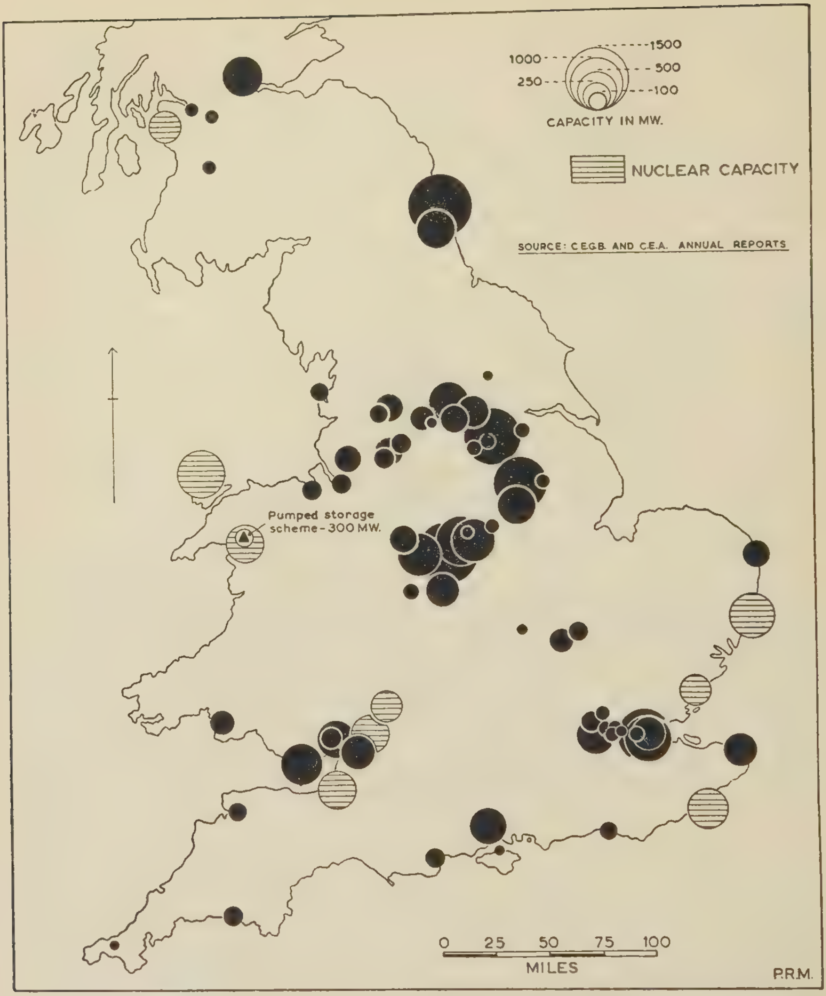
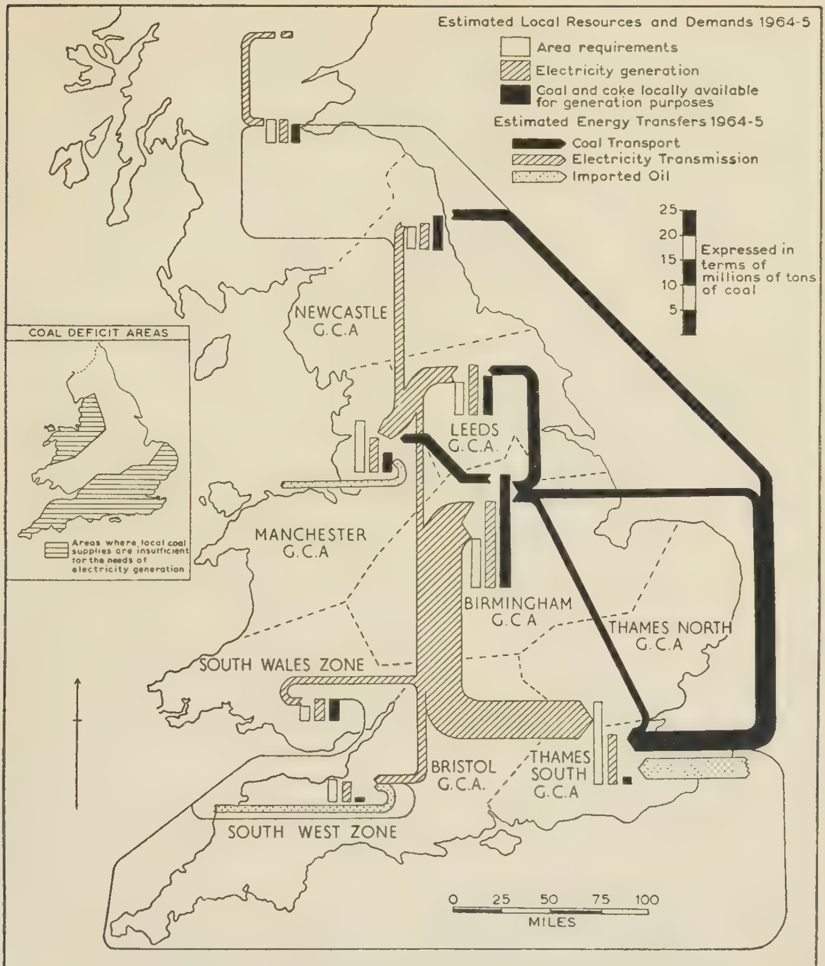

1000
1500
250
500
100
CAPACITY IN MW.
NUCLEAR CAPACITY
SOURCE: C.E.G.B. AND C.E.A. ANNUAL REPORTS
Pumped storage scheme - 300 MW.
0 25 50 75 100
MILES
P.R.M.

Fig. 1.—Installed capacity of new conventional and nuclear generating plant. This map shows the capacity of new coal-fired plant installed in the period 1st April 1955 to 31st March 1960, together with extra plant planned at the latter date to the end of 1964. Stations for which consent is still being sought (Feb. 1961), such as the 2000 MW stations at Holme Pierrepoint and West Burton in the East Midlands, are not included.

The capacity of each nuclear station is also indicated, but the data in this case apply to a period extending beyond 1964; the Wylfa Head station, for example, will probably not be commissioned before 1967. Moreover, in the absence of official published figures, the capacities of the most recent nuclear stations are based on estimates.

factor; a halving of the load factor doubles the overhead charge per kilowatt hour. Since unit capital costs of a nuclear power station form about two-thirds of total unit costs, a reduction in the load factor is far more serious than it would be in the case of a coal-fired station where the proportions of capital costs and running costs are approximately reversed. There is, in fact, adequate base load on the electricity supply system to operate several nuclear stations at 100 per cent load factor



Source: Adapted from a similar map in "Pattern of Power," C.E.G.B. March, 1960

Fig. 2.—Estimated energy transfers in 1964–5. For the purposes of operating the electricity generation and bulk transmission system England and Wales have been divided into seven Grid Control Areas which are shown on this map. The Bristol Control Area is sub-divided into South Wales and South West Zones.

if this were technically possible. The Central Electricity Generating Board at present assumes an average load factor, over a period of years, of 75 per cent for the first commercial nuclear stations.[17] This point is important in the present discussion because a considerable proportion of the base load is on the coalfields, the areas where the competitive power of coal-fired stations is strongest. Although the running costs of nuclear stations will be lower than those of conventional plants, the total cost of nuclear power will have to be competitive with conventionally generated power before it would be economically justifiable to build nuclear stations in such areas. However, the situation is made more complex by the fact that the demand for electricity and the coal supplies needed to provide for extra generating capacity are both unevenly distributed throughout the country, in discordant spatial relationship to each other.

The Generating Board has classified the various areas of England and Wales as either "coal-deficit" or "coal-surplus" areas depending upon the amount of local coal available for power generation (see Fig. 2). Quite clearly, the coal-deficit areas include some of the most densely populated and heavily industrialized areas of Britain. In southern England there is very little coal and a great demand for electricity; in the northwest only a modest amount of coal is available but there is also a large demand for electricity. In the northeast and South Wales there is a small surplus of coal and in the East Midlands and Yorkshire there is a substantial surplus of steam coal from the Yorkshire-Notts-Derby coalfield.

Under the system of coal-fired generation the electricity needs of the coal-deficit areas could be met in two ways. Coal-fired stations could be built in areas of coal surplus and power carried by the grid to the deficiency areas. The alternative course of action was for coal- or oil-fired stations to be built in the deficit areas and fuel carried to them. Both of these courses have been followed but, since 1947 especially, official policy has emphatically favoured the first of these alternatives for base load stations, stations in the second category largely carrying peak loads. Base load stations dominate the pattern of electricity generation and the major locational force acting on these stations since 1947 has been exerted by those coalfields with surplus coal available for new generating capacity.[18] Since the nuclear stations will be carrying base load, it is with these conventional stations that they should be compared.

The fact that electricity can now be generated by means of nuclear reaction has radically altered the situation. A 500-MW coal-fired station of modern design consumes up to 5000 tons of coal a day; a nuclear plant of the same capacity needs only half a ton of uranium a day. The uranium is of such high value in relation to both bulk and weight that transport costs can be virtually ignored. Thus, in the case of nuclear stations, the fuel supply factor is so diminished in locational importance compared with new coal-fired plants that much more attention can be given to the market when locational decisions are being made.

The result of this can be seen in the locations which have been chosen for the nuclear plants. Six of the first nine sites (i.e. excluding those proposed but not yet confirmed) are south of the line from the Bristol Channel to the Wash; this is the area where the largest power deficits are to be found and also where coal for conventional generation is least readily available. The Dungeness site is well placed for the market in the southeast,[19] the Sizewell and Bradwell stations will supply bulk electricity to London and areas of rapidly increasing demand in East Anglia. The Hinkley Point, Berkeley and Oldbury stations, close together on the Severn estuary, will supplement supplies in the southeast and southwest. Of the three other stations, those at Trawsfynydd and Wylfa Head will help to serve the market in the northwest of the country, another coal-deficit area. In Scotland the main load centre is Glasgow and the Clyde Valley. The South of Scotland Electricity Generating Board estimates that by 1965 the load will have risen by 80 per cent on 1957 figures.[20] The nuclear station at Hunterston will contribute towards satisfying some of this extra demand.

Nevertheless, the nuclear stations are not being located as close to the load centres as one would expect if nearness to these centres was the sole and overriding consideration; in fact most of them are a considerable distance from the population concentrations which they are expected primarily to serve. While this has been made possible by the provision of the new 275 kV Supergrid, other factors are exerting considerable influence on the choice of site.

Factors involved in the choice of sites for the nuclear stations

1. *Water supply.* One of the most important siting requirements for a nuclear generating station is water, primarily for cooling but also for other purposes. A nuclear power station requires nearly twice as much water as a modern coal-fired station of equivalent generating capacity, largely because of the lower steam pressures involved in nuclear generation. The supply of water must be continuous because, to produce electricity at the lowest cost, the nuclear stations have to be planned as base load stations. It is desirable for the site to be not more than thirty feet above water level. Below this height siphoning is possible, whereas every foot above involves direct water pumping.

As a rule, the water supply requirements can be satisfied only by going to the sea coast or a tidal estuary. The Trawsfynydd station is unique in that it will be completely dependent upon an inland source of water. Every other nuclear station so far projected is, or will be, on tidewater.

2. *Land and foundations.* Land is required for the generating plant and other technical equipment and also for normal administrative buildings. The area of land required is not large, usually something in the order of 100 to 200 acres. The extensive railway sidings associated with conventional stations are dispensed with altogether. The fuel is in the form of ingots supplied by the Atomic Energy Authority and transported by road. One lorry-load a day is more than sufficient to supply a 500-MW station. Land for waste disposal (an important siting requirement for a conventional plant due to the large amount of ash produced) is at a minimum for nuclear stations. The only item which can come within this category is the cooling pond in which the used and irradiated uranium ingots are placed, for a period of

approximately three months, before being removed to one of the Atomic Energy Authority's plants for further treatment. Foundations should preferably be of rock capable of bearing heavy loads because of the great weight of the reactors and their protective concrete sheathing.

3. *Labour.* A 500-MW plant, once fully in operation, would need a permanent labour force of 300–400 people, about half of these being fairly highly trained technical staff. Thus the greatest demand for labour arises during the construction period, which lasts between five and six years and during which, at the peak period of activity, the labour force for a station of this size may be in the region of 2000–3000 men. However, the sites chosen are all in areas of relatively low population density. The cost of labour, and hence the additional cost of importing labour, is so unimportant in relation to other requirements that the local availability of labour has been of little significance in the choice of sites for the stations.

4. *Linkage with the Supergrid.* The 275-kV Supergrid is partly designed to transmit bulk supplies of electricity over the country. The cost of an overhead 275-kV transmission line is approximately £25,000 per mile. It is, therefore, desirable for the stations to be as close as possible to a linkage with existing or planned 275-kV lines.

This factor was particularly important in the choice of Hunterston as the site for a nuclear station. It was established that, wherever the station was sited on the coast of Ayrshire, the output of electricity must come into the Scottish Board's main distribution network at a point a little to the south of Paisley. This is to be one of the focal points in the Board's future very high-voltage network. An alternative site was proposed on a disused war-time aerodrome at Turnberry Point, to the south of Portencross. This was in respect to all factors except distance from the grid a very reasonable alternative to Hunterston. However, because of the difference in distance from the grid link-up, it would have cost £1·5 million more for a transmission line from Turnberry Point.

5. *Government policy.* The Government White Paper of February, 1955, stated: ". . . the reactors that will be built for the commercial production of electricity will present no more danger to people living nearby than many existing industrial works. Nevertheless, the first stations, even though they will be of inherently safe design, will not be built in heavily built-up areas".[21] The working criterion seems to be that a nuclear station should be at least five miles from urban centres with a population of 10,000 or more.

In relation to this factor one might consider the case of the site at Dungeness. Objections to this site were put forward at the public inquiry, held at Lydd, on the grounds that the Dungeness area is of outstanding scientific interest and that its isolated and unusual character should be preserved from development. It was represented by Kent County Council that a site known as Reckham Mead, at Cliffe Marshes on the Thames estuary, should be considered as an alternative.

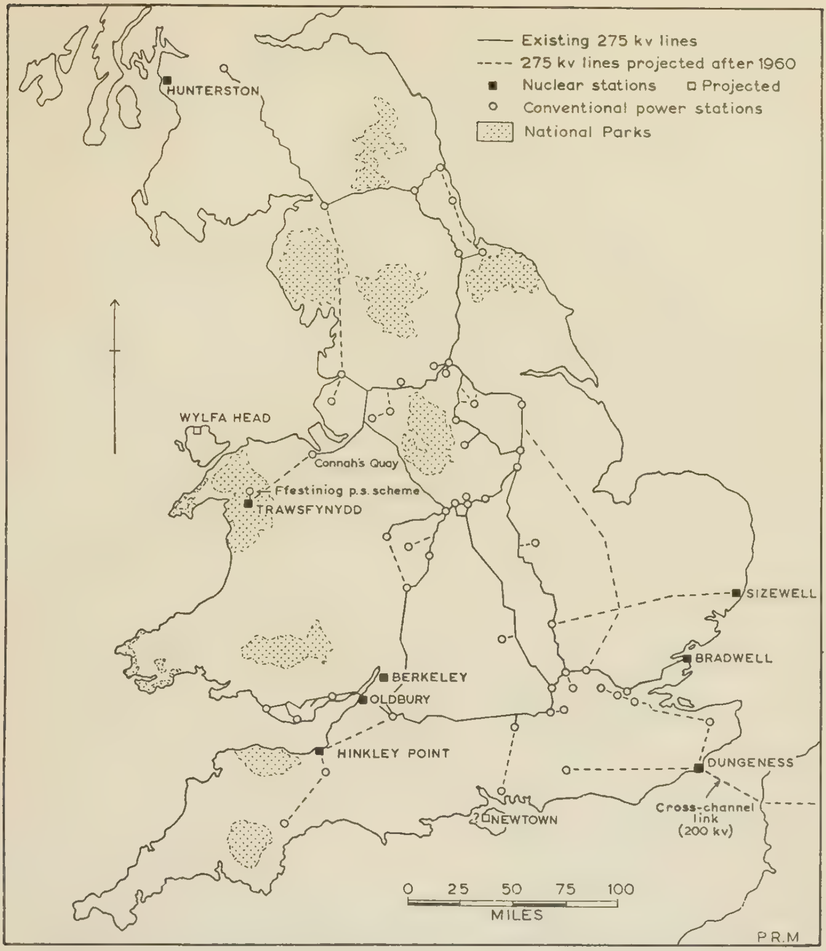


Fig. 3.—Supergrid Transmission, existing and proposed development. Proposed transmission routes are shown diagramatically as straight lines and only a selection of existing conventional stations are represented. Confirmed sites for nuclear stations are shown as black squares.

However, it was pointed out that this was not suitable because of the presence of large built-up areas in the Medway towns and at Southend, only a little over five miles across the estuary.

Controversy over the power station sites: the amenity issue

At present, coal stocks are high, there is a world glut of oil and it is now cheaper to make electricity from oil than from coal, at least in those parts of the country away from the sources of cheap coal. But even though the cost of the electricity which they produce is not yet competitive with that from coal- or oil-fired plants, in the long term it would seem desirable for the U.K. to have a number of nuclear power stations. If we are to have them, it would seem sensible to obtain experience in their operation as quickly as possible. However, the various requirements of such stations seem to make it necessary for them to have sites within rural Britain. Some of the sites most suitable from a technical and economic point of view have been, and may continue to be, in areas considered by many responsible authorities to be of considerable scenic beauty, high amenity value and, often, of considerable interest to natural scientists.

Of several bodies opposed to the establishment of nuclear power stations in such areas, the National Parks Commission is the most important. The attitude of the Commission was made clear in its Annual Report published in December 1958. This Report stated, "We have never doubted that our duty is to challenge any such infringement of the quiet and rural character of National Parks and other areas of beautiful landscape and we shall continue to do so". Large-scale installations such as nuclear power stations, ". . . should be allowed . . . only where it can be conclusively shown that the choice of site is in the overriding national interest". Lord Strang has referred to, ". . . the increasing assaults upon the National Parks from the great statutory developer . . . in spite of all that the defenders of landscape have been able to do, it has not proved possible to preserve National Parks from the erection of installations which are quite out of place in them". Other bodies have been equally emphatic in their reaction. The Council for Nature described the taking over of part of Dungeness for a nuclear station as "a scientific tragedy".

The main objections to the siting of the power stations in such areas seem to be as follows:

First, the buildings will be on such a large scale that they will dominate and thus change the rural character of the landscape where they are sited. The National Parks Commission states that it does not desire to sterilize the National Parks from all kinds of development or to turn them into "museum pieces", but it is regarded as impossible for amenity areas of this nature to absorb buildings of the size of nuclear power stations, with their attendant overhead power lines.

Secondly, this attitude has been strengthened by reference to a working life of only twenty to thirty years for a nuclear station, after which the reactors would become too radioactive for further use. It has been pointed out, by the Generating Board's technical experts, that because of the radioactive material within the reactors it would be impracticable, with present techniques, completely to demolish them or even to knock them down to ground level for many years after they had ceased to be used.[22] The length of immobilization of the reactor is dependent on the longest half-lives of the more energetic radioactive materials contained within the pile. They could be demolished, if at all, only at enormous cost. As a result, there has been expressed some concern regarding the possibility of "nests of disused and ugly reactor buildings being scattered around the countryside".[23]

In defence of the Generating Board, which has chosen its sites in conjunction with experts from the Atomic Energy Authority,[24] the following comments have been made at various times on these issues:

(a) National Parks should be avoided when and where possible, but as they now cover over one-eleventh of the area of Britain, and because they are increasing in number fairly rapidly, it becomes more and more difficult to avoid them, given the present combination of technical, economic and political considerations affecting the siting of nuclear stations.

(b) A power station can be designed to form part of a new landscape which is not necessarily less attractive than the original.

The new nuclear stations need involve no noise, smell, dust, smoke or vibration and there will be no need for tall chimneys. The routes of the overhead power lines are decided upon only after very careful consultation with relevant planning departments and other responsible authorities; to put them underground would more than quadruple their cost. Because the electricity will be fed into the grid it is not likely that the presence of a nuclear station will attract subsidiary industries.

(c) With regard to the length of the life of a nuclear power station the Board points out that the twenty-year period has been taken as an estimate for accountancy purposes. For the same purposes the life of a conventional station is taken as twenty-seven years but in fact several stations older than this are in current use. Techniques may well be evolved for dealing with the "worn-out" reactors, even to the extent of complete replacement.

(d) Not all the areas within a National Park are of equal scenic value; within the administrative areas of the Parks are areas of very high landscape value separated by less valuable stretches of land.

This point was made at the Trawsfynydd public inquiry by one of the Snowdonia Park Commission's planning advisers, Professor J. S. Allen. To some extent the acceptance of this fact is implicit in the policy which the Snowdonia Park has adopted towards afforestation, which is permitted within certain areas of the Park but not in others. Such a policy implies not only that some areas may be changed both in land use and appearance but also that there is a considerable variation in the value of the scenery within the Park's Boundaries.

(e) A nuclear power station can confer definite advantages by the provision of employment in areas where unemployment and, in some cases, depopulation have been problems for some time.[25] The road improvements which are often needed are of lasting benefit to the areas concerned.

One result of these conflicts of interest has been that in many cases the approval of a site has necessitated a public inquiry. In no instance, however, has Ministerial refusal been given to a site for which the Board has asked and there is some feeling that a project is submitted only when it is at the stage of being a *fait accompli.*

A DETAILED EXAMPLE: THE TRAWSFYNYDD NUCLEAR POWER STATION

The discussion so far has been in rather general terms. It is illuminating to consider a particular station in some detail in order to see how the factors interact in making the locational decisions. The Trawsfynydd nuclear station has been chosen for this purpose. Each of the nuclear power station sites is in some way unique and Trawsfynydd is no exception, but at the same time it illustrates the working of all the factors which have been described.

The Trawsfynydd station is being built to serve the needs of the Manchester Grid Control area. This particular Control Area includes Lancashire, Cheshire, part of Shropshire, and North Wales. Within the area the heaviest demand for electricity lies in Lancashire and the western part of Cheshire. The station at Trawsfynydd will be of 500-MW capacity; no more than 200 MW at the most will be absorbed in North Wales itself.

Coal for the generation of electricity in the Control Area is available in the vicinity of St. Helens and in the Manchester area but, taken as a whole, this is a coal-deficit region. It is estimated that twelve million tons of coal would be needed to produce the electricity required for the area in 1965 and the coal available locally for this purpose amounts to only two and a half million tons per annum. Thus the Generating Board plans to provide for some of the growing demand for electricity by the construction of nuclear power stations. Given the need for such stations within this area, the question then arises as to the whereabouts of the best sites.

Within the Control Area, inland water resources are very poor in relation to the amounts required by a station of this size; it will need 865 million gallons of water per day for all purposes. Thus a coastal site would seem to be called for but much of the coast in the Grid Control Area is either heavily populated (Lancashire has an average population density of 2700 per square mile and the most heavily populated coast of all the English counties) or obstructed by wide stretches of sand and mudflats. The first of these considerations is relevant to stated Government policy with regard to the location of nuclear power stations and population density; the second consideration makes the provision of cooling water difficult. The Board therefore turned its attention to North Wales.

Within North Wales there is no shortage of solid rock for firm foundations and large areas of countryside are relatively sparsely populated in comparison with the rest of the Control Area. However, other technical requirements are not so easily satisfied. First, many of the otherwise technically suitable sites are remote from the point of consumption or linkage with the Supergrid. Secondly, it is not easy to find water in sufficient quantities away from the coast. A third consideration is that extensive areas in North Wales fall within the National Parks or are areas of striking natural beauty, even though not officially under the jurisdiction of the National Parks Commission.

The Trawsfynydd station is within the boundaries of the Snowdonia National Park. After considering most of the Merionethshire coast and some sites elsewhere in North Wales the Board decided to press for a station at Trawsfynydd which, although inside the National Park, was technically and economically very suitable. Other sites were rejected either because they were technically less suitable, in areas of even greater landscape value or capable of taking the bigger power stations which the Board expects to be building in five or six years' time.

As the station is intended primarily to satisfy some of the demand in Lancashire and West Cheshire it might appear at first sight to be a long way from the point of consumption. In fact this is not the case. Only five miles of transmission line will be needed to connect the station with the Supergrid. This is because of the presence at Tan-y-Grisiau (Blaenau Ffestiniog) of a large pumped-storage scheme which was under construction when the nuclear station was first suggested.[26] The pumped-storage scheme was planned to link up with the 275-kV grid system and a coal-fired power station at Connah's Quay. The plans for the transmission line for this project, involving approximately 45 miles of overhead cable, had already been approved in principle before the nuclear station was projected. In effect therefore the nuclear station will be connected to the grid at Blaenau Ffestiniog. Furthermore, it is technically advantageous for the station to be linked up with the pumped storage scheme which will need electricity during off-peak periods; this demand will contribute towards a fuller load factor for the nuclear station.

The Trawsfynydd station will require cooling water at the rate of 35 million gallons (150,000 tons) per hour. This water will be drawn from Trawsfynydd Lake, an artificial lake constructed by the predecessors of the Generating Board in connection with the Maentwrog hydro-electric scheme.[27] It is hoped that this lake, which is owned by the Board, will satisfy both the requirements of the nuclear station and the existing Maentwrog hydro-electric power station. For two reasons the water supply system would seem to call for some further description. First, as has already been stated, this site on an inland supply of water is so far unique. Secondly, the lake will have to be modified to a considerable degree in order to provide sufficient water at the correct temperature.

The Trawsfynydd reservoir was formed in the nineteen-twenties by flooding a wide, flat, upland valley. The valley is that of the Afon Prysor, a stream flowing westwards from the Migneint Hills and turning north round the bluff on which Trawsfynydd village stands. The lake was formed by building three small dams at the northern end of the valley just where the land starts to fall to the Vale of Ffestiniog (see Fig. 4). The southern end of the lake reaches almost to the watershed of the Afon Prysor, beyond which the land slopes away in a southerly direction with the Afon Eden running along an ever-deepening valley until it joins the Afon Mawddach near Dolgellau. There is a fourth shallow dam at the southern end of the reservoir evidently to prevent any possibility of water flowing southwards over the watershed. The site of the nuclear power station covers some one hundred and eighty acres along the northern lake shore. It lies over the northern lip of the valley where the ground falls in an irregular fashion to the north and is for the most part below the level of the normal lake surface.

At the public inquiry held at Trawsfynydd in February 1958, it was stated that, provided the whole of the lake could be brought into play, it would provide sufficient water for the needs of the station.[28] The deepest part of the lake is at the northwest corner and the shallow end is at the south. Water will be drawn into the power station at a point near the northwest shore, i.e., the water will be drawn in from the deepest and coolest part of the lake. After the cooling water has been used, it will be returned to the lake at a place near the northeast corner and by a system of channels and embankments the flow will be led along the east side of the lake towards the southern end. The water will then slowly find its way back through the main body of the lake to the point of intake; it will be slowly circulating in a clockwise direction.

The total water content of the lake is 7300 million gallons, the annual water input being, on average, 28,600 million gallons from streams. This comes mainly from one stream, the Prysor, which has a very wide variation in flow between summer and winter. In winter the average monthly inflow into the lake is 3500 million gallons. The average summer monthly inflow is 1500 million gallons. Thus there is a variation between summer and winter of 1 : 2·3^{r} and in dry weather there may well be some limitation on the use of the Maentwrog hydro-electric station.

There will be two reactors at Trawsfynydd. Foundation conditions are good, with bedrock not much more than ten feet below the surface. Because the ground was sloping and irregular it has had to be levelled in more than one terrace. The site area, which consists of land of low agricultural value, was already owned by the Generating Board and the complications of compulsory purchase orders have thus been avoided. When the station is in full production these one hundred and eighty acres will produce electricity worth £8·5 million per annum.

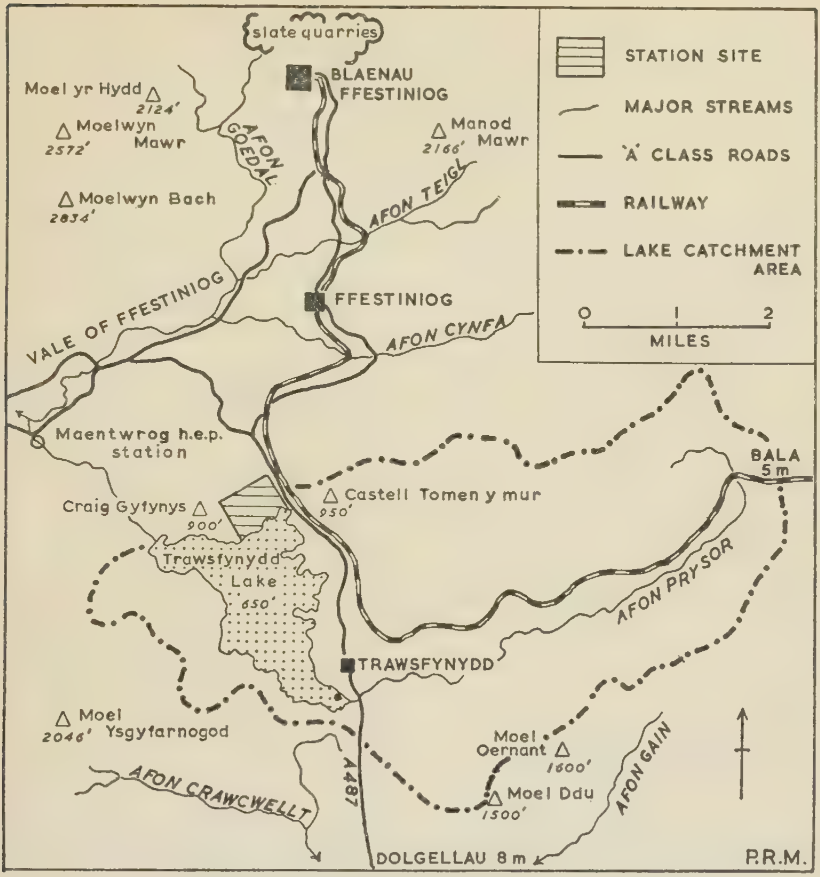


Fig. 4.—Site and surroundings of Trawsfynydd Nuclear Station.

SUMMARY AND CONCLUSION

The factors determining the general areas of the country within which nuclear power stations are being located are: first, the relative cost of power generated by conventional and nuclear plant; secondly, the mobility of the nuclear stations with regard to fuel supplies; thirdly, the regional pattern of electricity demand combined with the degree of availability of coal for electricity generation. These three considerations are so closely interlocked that it is difficult to allocate a superior degree of importance to any one of them. They have operated in the choice of location for all of the first commercial nuclear power stations and seem likely to continue as important considerations in the foreseeable future.

With regard to siting requirements, by far the most important factors are water supply, linkage with the Supergrid and the safety precautions embodied in official Government policy. Solid, heavy-load-bearing rock foundations are preferable but not essential;[29] the local availability of labour and facilities for waste disposal are, apparently, relatively unimportant considerations. In general, the technical and economic siting requirements are such that a rural rather than an urban site is called for. Government policy emphasizes this tendency and serves to restrict even more the sites which can be considered suitable for development.

The site of the Trawsfynydd nuclear station, technically very suitable but within the boundaries of the Snowdonia National Park, pinpoints the conflict of interest which has been outlined in this paper. Of this site, the National Park Commission stated at the Trawsfynydd Public Inquiry "Trawsfynydd is the central point of that splendid panorama of mountain round from Ffestiniog, from Moelwyn Bach on the west to Manod Mawr on the east, and the steep face of this range, particularly from the south side of Trawsfynydd reservoir, is one of the finest mountain prospects in Wales. A nuclear power station in such a setting could not appear other than a huge and overmastering imposition". The Report of the Principal Inspector of the Ministry of Housing and Local Government was also opposed to the site.

The arguments put forward for the protection of the National Parks and similar areas should not be minimized because they cannot be expressed in terms of direct financial gain or loss. On the other hand it must also be realized that, for one purpose or another, nearly 40 per cent of the land of Britain is now "protected". There seems only one possible way of lessening the problem in the immediate future and that is by relaxing the present safety precautions. Government policy states that nuclear stations should be sited in areas of low population density and the sites which have been chosen achieve a degree of isolation which gives effect to this policy. If the nuclear power stations are safe, it would seem that the existing ordinances governing their siting tend to be overcautious and may well be modified in the near future. The major arguments against any relaxation seem to be the uncertainty regarding the useful life of the plant and that, in time of war, such power stations would be potentially dangerous and evacuation measures could be more readily implemented in sparsely populated areas. Nevertheless, if some loosening of the regulations does occur, it will ease the dilemma in which both sides at present find themselves.

REFERENCES

[1] *A Programme for Nuclear Power*, Cmnd. 9389.

[2] *Capital Investment in the Coal, Gas and Electricity Industries*, Cmnd. 132, April, 1957, and *Annual Report* of the Central Electricity Authority, March, 1957, pp. 12–13.

[3] For example, the Generating Board has considered this possibility at Hinkley Point (a "full" power station involves the use of two reactors).

[4] Cmnd. 1083, June, 1960.

[5] 1913 to 1957 figures from Ministry of Power *Statistical Digest*, 1957. Data for subsequent years from *The Economist*, 16th Jan., 1960, p. 223.

[6] W. F. Luttrell, "Realities of the National Fuel Position", *Times Review of Industry*, Feb., 1958, p. 11.

[7] *Power Progress*, Electricity Council, 1959, p. 6, and *Annual Report* of the Central Electricity Generating Board, March, 1960. Some of the figures for early years are partly estimated and may not be fully comparable with those for later years. They do, however, show the general trend of development. Installed capacity figures for 1930 and 1938 relate to the financial years 1930/31 and 1938/39.

[8] W. F. Luttrell, *op. cit.*, p. 11.

[9] *Plan for Coal*, National Coal Board, Oct., 1950.

[10] *Investing in Coal*, National Coal Board, April, 1956, p. 13.

[11] C.E.A. *Annual Report*, March, 1957.

[12] On the basis of a 75 per cent load factor. (The load factor is the ratio, expressed as a percentage, of (a) the number of units of electricity sent out during a given period, to (b) the number which would have been sent out had the maximum demand been maintained and supplied throughout the period.)

[13] C.E.A. *Annual Report* for 1957, *op. cit.*, p. 12.

[14] *Revised Plan for Coal*, National Coal Board, Oct., 1959.

[15] *The Economist*, 25th June, 1960, p. 1356.

[16] *Annual Report* of the Central Electricity Generating Board, March, 1960, p. 24.

[17] The annual load factor of conventional plant in 1920 was about 30 per cent, calculated on a basis comparable with the integrated supply system of to-day. By 1948 it was estimated to be 43 per cent. Further progress was made over the following ten years and in 1958 the actual annual load factor was 48 per cent (*Power for the Future*, Electricity Council, 1959).

[18] For a full discussion of the factors involved in the geographical pattern of electricity generation by conventional stations see the following articles by E. M. Rawstron: "The distribution and location of steam-driven power stations in Great Britain", *Geography*, vol. xxxvi, 1951, pp. 249–63; "Changes in the geography of electricity production in Great Britain", *Geography*, vol. xl, 1955, pp. 92–7.

[19] This station will also be connected with the proposed cross-Channel linkage. In June, 1956, the former Central Electricity Authority approved a scheme for inter-connecting the electricity system of the Authority and Electricité de France. The project involves direct current transmission through a single submarine cable between Dungeness and Boulogne, operating at 200,000 volts, with a transmission capacity of 160,000 kilowatts in either direction.

[20] *Report on the Public Local Inquiries . . . for consent to the construction of a nuclear generating station at Hunterston*, Scottish Home Department and Department of Health for Scotland, H.M.S.O., Edinburgh, 1957.

[21] Cmnd. 9389, *op. cit.*, p. 9, para. 37.

[22] At the Trawsfynydd Public Inquiry.

[23] Sir Herbert Griffin, Secretary of the Council for the Preservation of Rural England, quoted in *The Guardian*, 17th Oct., 1958.

[24] The link between the A.E.A. and the C.E.G.B. is the Reactor Location Panel, established on 28th March, 1955. In particular, the Panel is concerned with the siting of nuclear generating stations.

[25] It is difficult to say how much weight should be attached to this argument. The intense demand for labour is short term, after which it falls off sharply.

[26] The Tan-y-grisiau Scheme is designed to help supply the peak load on the grid system. At off-peak periods electricity is used to pump water from a low-level reservoir to a high-level reservoir. In the succeeding period of peak demand the water flows back to the low-level reservoir to generate electricity from water turbines.

[27] One of the oldest H.E.P. stations in Britain, constructed in 1928.

[28] *Report of the Public Inquiry concerning proposals to construct a Nuclear Power Station at Trawsfynydd together with certain overhead transmission lines*, Ministry of Power, H.M.S.O., London, 1958.

[29] At Bradwell, an investigation into the sub-surface conditions showed the main features to be London blue clay extending to a depth of at least 150 feet, overlaid by some 20–30 feet of stiff brown clay. The load-bearing properties of the clay improved with depth and all foundations have been carried down into the London clay. It was found that exposure of the London clay caused rapid deterioration of the bearing properties and special techniques had to be used to enable the clay to be sealed immediately after excavation depth had been reached.

This Changing World

THE CHANGING FACE OF AFRICA

The wind of change, to which the Prime Minister of Britain referred in his famous Cape Town speech of 3rd February, 1960, has blown throughout the continent of Africa with some violence and quite remarkable effect during recent years, and especially during 1960. As a result the political map has been transformed as more and more countries have gained their independence and loosened their ties with the European nations with which they have been associated. In the process there have been many important changes with which geographers must concern themselves. Several unfamiliar names not to be found in any but the most recent atlases have appeared, such as the Central African Republic (formerly Ubangi-Shari, a province of French Equatorial Africa), Mali (which used to be the French Soudan), and the Malagasy Republic (formerly Madagascar), though these may come into as common use as that of Ghana, which replaced the name Gold Coast only in 1957.

A generation ago the only independent states in Africa were countries with rather special circumstances and conditions such as Liberia, a republic since 1847 but with strong financial links with the United States of America; the Union of South Africa, to which Dominion status was granted in 1910; Egypt, whose independence was determined by the agreements of 1922 and 1936; and Ethiopia, which lost its independence for five years following its conquest by Italy as a result of the war of 1935–36.

Today, in contrast, vast areas (those unshaded on the map) are independent; twenty-two countries have in fact become independent during the five years since the Anglo-Egyptian Sudan became the Sudan Republic in January 1956, and many of them, as shown in the table, are member states of the United Nations. In some cases the break with the European country previously responsible for its administration has been complete and absolute: the outstanding example is that of the Congo Republic, formerly the Belgian Congo. Guinea declared its total independence of France following the referendum held throughout French Africa in 1958, while other parts of West Africa have recently decided not to remain members of the French community (Mali, the Ivory Coast, Dahomey, Upper Volta and Niger), though willing to keep close economic ties with France. But large parts of tropical Africa maintain links with the European nation with which they were formerly associated, either through membership of the British Commonwealth (as with Ghana, the Federation of Nigeria and Sierra Leone) or of the French community (as with the Malagasy Republic, Senegal and those countries formerly known as French Equatorial Africa). Countries that are still not independent include Algeria, whose relations with metropolitan France remain the subject of complex and troubled negotiations and the cause of much violence and unrest; the Portuguese overseas territories of Mozambique, Angola and Portuguese Guinea; the Spanish areas of Guinea, Sahara and Ifni; and various British territories, mostly south of the equator. Of the latter, some seem to be too small to become the basis of self-governing, independent political units or are unlikely ever to become economically viable units: examples are Zanzibar, the Gambia and the High Commission Territories (Basutoland, Bechuanaland and Swaziland). The others are those where—significantly—there are important European minorities who have settled permanently in tropical Africa and who feel strongly that they have made vital contributions to the social and economic development of the countries where they live and of which they rightly regard themselves as citizens. Settler groups of some size and, at least until very recently, of very considerable political power are found in both the Rhodesias and in Kenya and, to a less extent, in Nyasaland and in Tanganyika.

In several of the British areas important constitutional conferences have been held recently, or will take place during 1961, to determine the pattern of future political development. Decisions relating to future self-government or independence must take note of the legitimate interests of long-established minority groups of Europeans, Asians, Arabs and others, as well as of the equally legitimate aspirations of the large and increasingly vocal African majorities. Preparations for self-government, in whatever form it eventually takes, and for the training of African leadership need to be put in hand as quickly and expeditiously as possible—if this has not already been done—in order to ensure that there shall be no repetition in these British areas of the chaos and tragedy of the Congo situation.

The map shows the political state of Africa in the first half of 1961, anticipating the independence of Sierra Leone (27th April, 1961) and the decision of the Union of South Africa to leave the Commonwealth on becoming a republic (31st May, 1961). It must be emphasized, however, that the changes of recent months have been so numerous and so swift that the map can be no more than an interim statement on the situation at a particular moment in time and may be out of date by the time of its publication. The implementation of the plebiscite held in the British Cameroons on 12th February, 1961, has been anticipated by including the northern portion as part of the Federation of Nigeria and the southern provinces within the independent republic of Cameroun. But at the time of writing there are numerous unsolved problems the solutions of which are impossible to foresee. Thus the situation in Kenya following on the general election is far from clear. The future of the Federation of Rhodesia and Nyasaland is under review and much discussion and dissension have arisen over the constitutions of the individual territories within the Federation. There are proposals for the closer political association of Ghana, Guinea and Mali which may or may not come to fruition. Even the Portuguese territories have been more affected by current tendencies in adjacent areas than the Portuguese authorities have previously admitted, as shown by recent disturbances in Angola.

The table is based on a wide variety of sources and attempts to give what is, it is hoped, reasonably reliable and up-to-date information. But there are often considerable discrepancies between statistics issued by governments and those included in standard reference books. As anyone familiar with the use of African statistics knows only too well, information of this nature must be treated with considerable reserve, but it is included in the table in the belief that some recently published figures are preferable to none at all or to those that are clearly out-dated.

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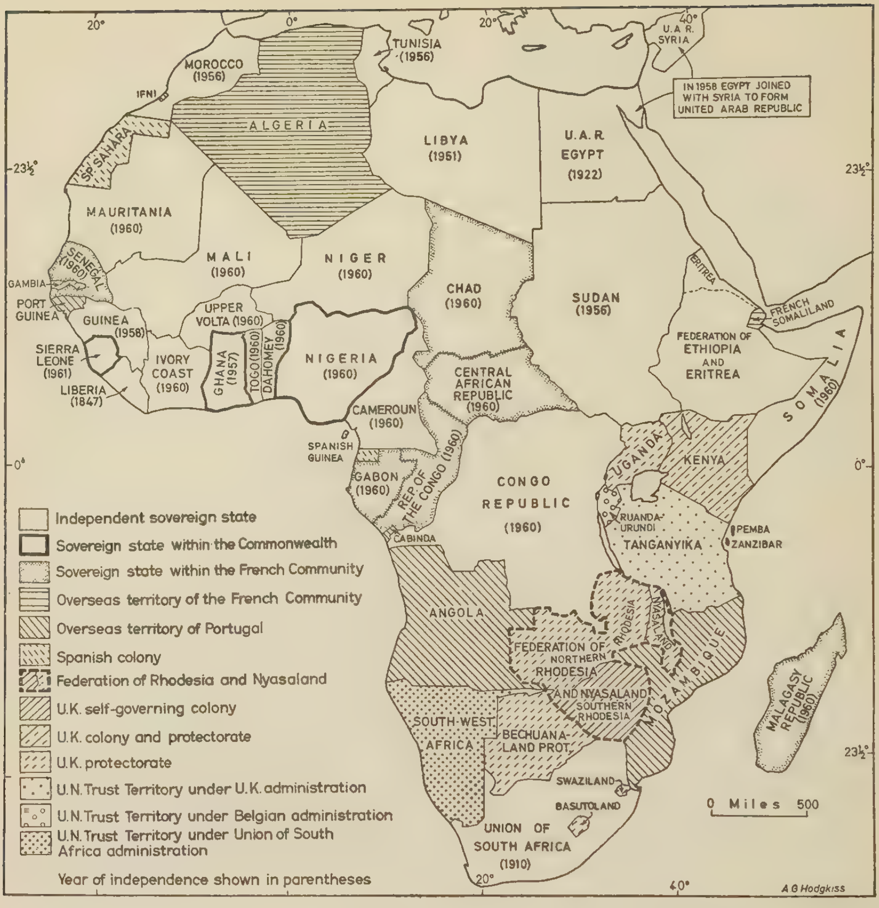


Country	*Status*	*Area in Sq. Miles*	*Population*	*Capital*
Algeria(1)	Overseas territory of the French community	855,900	10,300,000	Algiers
Angola(2)	Overseas territory of Portugal	481,000	4,508,000	Luanda
Basutoland	U.K. protectorate	12,000	650,000	Maseru
Bechuanaland	U.K. protectorate	275,000	337,000	Mafeking(3)
British Cameroons(4)	U.N. Trust Territory under U.K. administration	34,000	1,600,000	Buea
Cameroun(5)	Independent sovereign state*	167,000	3,250,000	Yaoundé
Central African Republic(6)	Independent sovereign state*	242,000	1,193,000	Bangui
Chad	Independent sovereign state*	496,000	2,610,000	Fort Lamy
Congo, Republic of The(7)	Independent sovereign state*	135,000	795,000	Brazzaville
Congo Republic(7)	Independent sovereign state*	905,000	13,700,000	Léopoldville
Dahomey	Independent sovereign state*	45,000	1,725,000	Porto Novo
Ethiopia and Eritrea, Federation of	Independent sovereign state*	505,000	22,706,000	Addis Ababa
French Somaliland	Overseas territory of the French community	9,000	69,000	Djibouti
Gabon	Independent sovereign state*	102,000	420,000	Libreville
Gambia	U.K. protectorate	4,000	289,000	Bathurst
Ghana	Independent sovereign state*	92,000	6,691,000(8)	Accra
Guinea	Independent sovereign state*	95,000	2,727,000	Conakry
Ifni	Spanish colony	750	38,000	Sidi Ifni(9)
Ivory Coast	Independent sovereign state*	184,000	3,100,000	Abidjan
Kenya	U.K. colony and protectorate	225,000	6,450,000	Nairobi

Country	*Status*	*Area in Sq. Miles*	*Population*	*Capital*
Liberia	Independent sovereign state*	43,000	1,500,000(10)	Monrovia
Libya	Independent sovereign state*	680,000	1,200,000	Tripoli
Malagasy Republic	Independent sovereign state*	228,000	5,200,000	Tananarive
Mali(11)	Independent sovereign state*	465,000	4,300,000	Bamako
Mauritania(12)	Independent sovereign state	418,000	730,000	Nouakchott
Morocco	Independent sovereign state*	174,000	10,330,000	Rabat
Mozambique	Overseas territory of Portugal	298,000	6,286,000	Lourenço Marques
Niger	Independent sovereign state*	489,000	2,556,000	Niamey
Nigeria(13)	Independent sovereign state*	372,000	35,280,000	Lagos
Northern Rhodesia	U.K. protectorate	288,000	2,460,000	Lusaka
Nyasaland	U.K. protectorate	37,000	2,860,000	Zomba
Portuguese Guinea	Overseas territory of Portugal	14,000	510,000	Bissau
Rhodesia and Nyasaland, Federation of(14)	British Federal State	475,000	8,430,000	Salisbury
Ruanda-Urundi(15)	U.N. Trust Territory under Belgian administration	21,000	4,650,000	Usumbura
Senegal	Independent sovereign state*	77,000	2,300,000	Dakar
Sierra Leone(16)	Independent sovereign state	28,000	2,260,000	Freetown
Somalia	Independent sovereign state*	250,000	1,864,000	Mogadishu
Southern Rhodesia	U.K. self-governing colony	150,000	3,110,000	Salisbury(17)
South-West Africa(18)	U.N. Trust Territory under Union of South Africa administration	318,000	554,000	Windhoek
Spanish Guinea(19)	Spanish colony	11,000	213,000	Santa Isabel
Spanish Sahara	Spanish colony	104,000	37,000	Villa Cisneros
Sudan	Independent sovereign state*	970,000	11,400,000	Khartoum
Swaziland	U.K. protectorate	6,700	267,000	Mbabane
Tanganyika	U.N. Trust Territory under U.K. administration	362,000	9,076,000	Dar es Salaam
Togo	Independent sovereign state*	22,000	1,100,000	Lomé
Tunisia	Independent sovereign state*	48,000	3,850,000	Tunis
Uganda	U.K. protectorate	94,000	6,538,000	Entebbe
United Arab Republic (Egypt)(20)	Independent sovereign state*	386,000	25,000,000	Cairo
Union of South Africa(21)	Independent sovereign state*	473,000	15,841,000	Pretoria
Upper Volta(22)	Independent sovereign state*	106,000	3,472,000	Ouagadougou
Zanzibar(23)	U.K. protectorate	1,000	299,000	Zanzibar

* Indicates membership of the United Nations.

(1) Including Saharan territories.

(2) Including Cabinda. Nova Lisboa has been the capital designate since 1926.

(3) Mafeking is in the Union of South Africa: an administrative capital *within* the Bechuanaland Protectorate will presumably be established as a result of the Union of South Africa's withdrawal from the Commonwealth.

(4) By a plebiscite held in February 1961 the northern portion voted to join Nigeria and the southern provinces to join Cameroun, but it has been thought advisable to leave the statistics as they were since arrangements for integration are not yet complete.

(5) Figures do not include the part of the British Cameroons that voted in February 1961 for integration with Cameroun (16,581 square miles, population *c.* 750,000).

(6) Formerly Ubangi-Shari.

(7) There is (March 1961) some confusion and dispute over the names of the territories formerly known as the French Congo (called "Republic of the Congo" on the map), and the Belgian Congo ("Congo Republic"). (*Whitaker's Almanac* uses "Congolese Republic" and British newspapers usually say simply "Congo" or "the Congo". Some reports of proceedings at the United Nations refer to them as respectively "The Republic of the Congo, the capital of which is at Brazzaville" and "The Republic of the Congo, the capital of which is at Léopoldville.)

(8) The figure for the census of 1960.

(9) The seat of government is Cabo Juby.

(10) This figure is one of many approximations: estimates vary from 1 million to 2½ millions.

(11) Formerly French Soudan. The Federation of Mali formed in 1958 consisted of Senegal and Soudan, but Senegal withdrew in September 1960, leaving Soudan as the Mali Republic.

(12) Mauritania's application for membership of the United Nations has been vetoed in the Security Council. If it becomes a member, it intends to join the French Community. Until 1958 its capital lay outside the territory, at St. Louis in Senegal. A new capital is being created at Nouakchott, 150 miles north of St. Louis.

(13) The official figures for the Federation of Nigeria include those for the British Cameroons under U.K. administration. As a result of the plebiscite of February 1961, 16,581 square miles of Southern Cameroons (population *c.* 750,000) became part of the independent republic of Cameroun.

(14) For figures of the individual countries in the Federation, see under Northern Rhodesia, Nyasaland and Southern Rhodesia.

(15) Elections are to be held during 1961, and it is anticipated that the Trust Territory will become autonomous and then achieve independence shortly afterwards.

(16) It is expected that Sierra Leone will become a member of the United Nations shortly after it becomes independent on 27th April 1961.

(17) Salisbury is also the capital of the Federation of Rhodesia and Nyasaland.

(18) Far-reaching changes in the constitutional position of South-West Africa were introduced by an act of the Union of South Africa Government in 1949, but the International Court of Justice ruled in 1950 that the territory was still under international mandate.

(19) Including Fernando Po, Annobon, Corisco Islands and Rio Muni.

(20) The figures refer only to the Egyptian Region of the United Arab Republic.

(21) The figures for South-West Africa are not included.

(22) Or Voltaic Republic.

(23) Zanzibar is a sultanate under United Kingdom protection. The 10-mile wide strip of the mainland in Kenya that forms part of the Sultan's dominions are administered by the British as the Kenya Protectorate under an agreement of 1895.

NEW PORTS IN DAHOMEY AND TOGO

In overcoming the natural hazards of the West African Coast, port development has followed a recognizable pattern. (See H. P. White, "The Ports of West Africa. Some Geographical Considerations", *Tijdschrift voor Economische en Sociale Geographie*, vol. 50, 1959, p. 1.) Techniques for overcoming the barrier of the surf have evolved from the use of surf boats operating from open beaches to artificial harbours with deep-water quays, for which the necessary capital investment has been made at a small number of ports, those exceptionally favoured with regard to communications with the interior. Thus the number of ports has been much reduced. This pattern of development, carried to its logical conclusion in Ghana with the concentration of port facilities on Takoradi and Tema, has recently moved a step forward in the new Republics of Dahomey and Togo, where the coastline is a continuous chain of sand dunes with a sandy beach shelving gently, a depth of 6 fathoms (36 feet) being reached ½ to 1 mile offshore. In many places the dunes are backed by shallow lagoons and in others by swampy lowlands, formerly lagoons. The beach is beaten by a fierce surf, which reaches heights of up to 8 feet. (See J. Darbyshire, "Sea conditions at Tema Harbour", *Dock and Harbour Authority*, London, vol. 38, 1957, p. 277.) The waves strike the shore from the southwest at an angle, which results in an easterly drift of sand along the beach, a very considerable tonnage being moved past any one point in the course of a year.

Along this stretch of coast (a distance of 110 miles) surf ports were established at various places including Lomé, Anécho, Grand Popo, Ouidah, and Cotonou. In 1892 a pier was built out through the surf at Cotonou, to be replaced in 1910 by a 240-yard long pier built on steel columns to allow the free passage of drifting sand, and projecting beyond the breaking surf. Barges of up to 25 tons capacity can be used instead of the small conventional surf boats to transfer cargo to and from ships at anchor in the roads. A similar pier was built at Lomé in 1904 (rebuilt 1912 and 1929).

On these two piers the railway systems and in later years the roads of the two countries converged, resulting in the extinction of all the other ports. Even to-day, however, there are no roads along the piers, and goods arriving by lorry must be transferred to railway wagons.

The cost of the various trans-shipments involved in working these two ports is thus very high. Furthermore, in common with many other West African ports, traffic at Cotonou has increased rapidly since 1945, from 146,212 metric tons in 1950 to 256,500 in 1956 (exports: 121,400 tons, of which 75,500 tons were palm oil and kernels; imports: 135,100 tons, 56,800 tons being cement and other building materials). The pier was ill-equipped to deal with this increase and congestion was serious. In 1954 ships lay waiting to load or discharge for a total of 556 idle days (37 per cent of the total number of days spent by ships in the roads) and this was of course reflected in the cargo rates charged. Also, the 21,700 tons of petroleum products imported into Dahomey and Niger in 1956 had to be landed at Lagos and taken through the lagoons to be enrailed at Porto Novo for Cotonou and up-country destinations. Heavy equipment such as locomotives also had to be imported by this route.

In 1952 work was started on an economic and technical report, completed in 1956, on the feasibility of building a deep-water port at Cotonou (summarized in M. Giraud, "Le port du Cotonou", *Travaux*, Grenoble, Feb. 1959, p. 73). The conclusion was reached that such a project was economically sound with traffic at the 1955 level, due to savings on lighterage and other trans-shipment costs, the reduction of ships' turn-round times, and the abolition of the costly Lagos–Porto Novo route. Savings would total (at present exchange rates) nearly £2 a ton and would allow interest at 3 per cent and amortization over 60 years on a capital outlay on the new port of £10 million. Three building methods were considered, to deal with the problem of the eastward beach drift: (1) to allow sand to accumulate on the west side of the new mole, entailing defence works on the beach on the lee of the harbour to prevent the coast erosion that would follow the cutting off of the sand supply; (2) to pump sand from the west to the east of the harbour; (3) to build the port as an "island" offshore linked to the mainland by a pier on columns.

The first method was eventually decided on and work started on 23rd October 1959, the capital being furnished by F.I.D.E.S., the agency by which the French Government makes capital available to members of the French Community. There is to be a long, curved western mole, over 2000 yards long, while the eastern mole will be straight and shorter, 880 yards, leaving an entrance 330 yards wide between the ends of the two moles. Inside the western mole is to be a deep-water quay 660 yards long and with a mean depth of water of 33 feet. Work is now going ahead on the main mole at a rapid rate. No suitable building stone occurring among the soft Secondary and Tertiary sedimentaries of the coastal zone, it was decided to open quarries on the flanks of an inselberg in the basement complex 101 miles to the north, near the railway to Parakou, whence a 3-mile branch was built up to the quarry.

Although a case may be made out for the economic viability of the project, this depends on what is for these days a supply of capital on very easy terms and there would appear to be some other than a purely economic incentive.

The answer lies in Cotonou being not only the port for Dahomey but for the inland country of Niger as well. It is a pardonable exaggeration to say that Niger is a Canada to Nigeria's U.S.A., for though a large country, the bulk of the population and the productive area is confined to a narrow zone along the northern border of Nigeria. The new port at Cotonou may be seen as an attempt to bind the new republic of Niger the more firmly into the French Community.

Groundnuts are the chief product of Niger, 98,000 tons being produced in 1956. Most of these find their way to railheads in Northern Nigeria, whence they are exported through Lagos. Determined efforts have been made to divert as large a tonnage as possible to Cotonou and also to route as high a proportion of the imports as possible that way, by "Operation Hirondelle", which included the improvement of the rail-road route from Cotonou at a total charge to F.I.D.E.S. of about £3 million. From Parakou railhead 200 miles of tarred road were built to Malanville on the Niger, where a bridge was constructed. From here 566 miles of gravel road were improved to Zinder. Heavy lorries, operated by the Compagnie Général Transafricaine and other smaller firms, work between Zinder and Parakou where traffic is handed over to rail. Through-rates on groundnuts and on such essential imports as cement and petrol are quoted at 40 per cent less than cost, the difference being made up by various Government funds. The G.C.T. also operates to Niamey and Gao and from Niamey to Ouagadugu, the railhead of the line from Abidjan in Ivory Coast.

There has been a long-standing desire for improved port facilities in Togo as well as Dahomey, and at one time there were proposals for a port common to the two countries. This would have been a wise measure, but the Dahomeyans wanted it to be at Cotonou and the Togolese at a point near the common frontier. The controversy finally ended in the decision to build at Cotonou specifically for Dahomey. The need for improved facilities in Togo remains, traffic at Lomé having increased, though more erratically, from 81,800 metric tons in 1948 to 109,700 in 1958. A deep-water port is therefore being planned for Lomé, though nothing definite has yet been decided. It would be difficult to find an economic justification for anything on the same scale as that at Cotonou, but the strategic one of endeavouring to remain independent of Ghana may lead this country to make the attempt.

Meanwhile large deposits of phosphates were proved in Togo in 1952 in the Tertiary rocks of the coastal zone. A consortium of North African mining companies was formed to exploit them and in 1957 a convention was signed between the Compagnie Togolaise des Mines du Benin and the Republic of Togo granting a long-term concession near Hahotoe of nearly 10,000 hectares and containing proved reserves of 50 million tons. A railway has been built, 14 miles long, from the open-cast mine to the coast at Kpémé (22 miles east of Lomé) where a washing plant and port facilities have been built. The latter consist of a pier, 1300 yards long, built out through the surf into deep water beyond. At the end the water is 42½ feet deep and ships of up to 20,000 tons can be loaded. It is hoped that exports will shortly reach an annual rate of 500,000 metric tons and eventually reach 750,000. The pier will also be able to deal with petroleum imports.

When the project is in full operation it will be one of the major mining ventures in West Africa, while the phosphates also represent a vital economic resource to Togo. At present the country is solely dependent for its overseas trade on modest exports of agricultural products which in 1958 amounted to but 43,100 metric tons, of which palm kernels amounted to 26 per cent and cocoa just under 20 per cent.

University College, Ibadan H. P. WHITE

THE INDUSTRIAL EVOLUTION OF WEST PAKISTAN

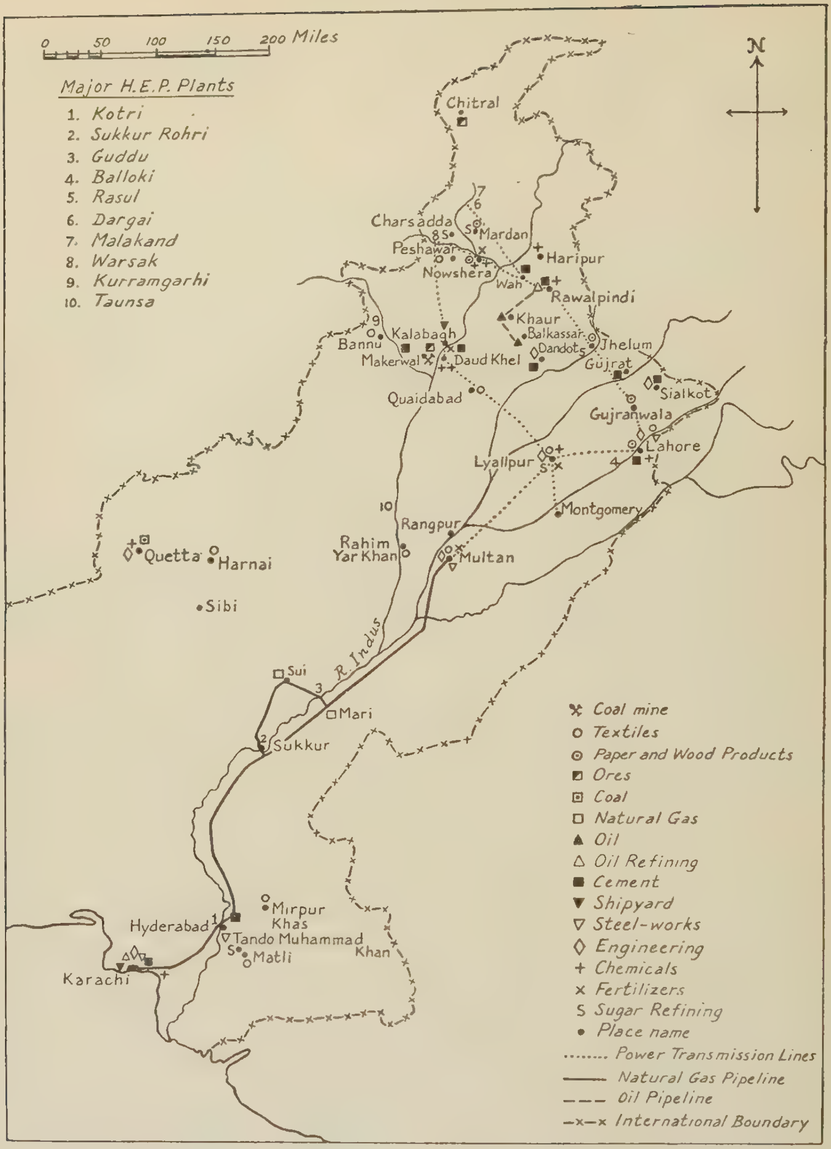
West Pakistan comprises three distinct regions; the mountains of the north and west, the tableland of Baluchistan, and the plains of the Indus Basin. Industrial development has been almost exclusively confined to the last, with the minor exceptions of the Quetta-Harnai area and Bannu where an attempt has been made to foster development. The increasing development of the north is well illustrated by the movement of the capital to Islamabad, near Rawalpindi, analagous to the movements away from the coasts of the capitals of Russia, Turkey and Brazil.

The dependence upon water supply is obvious; for instance in the Peshawar district the Warsak scheme was the first multi-purpose project to be undertaken producing 150,000 kW and irrigating 60,000 acres. Two features emerge from the map of industrial distribution. The first is the zone of separation between the Karachi-Hyderabad region and the north, which may be compared with the separation of East and West Pakistan. The second is that the northern industrial area widens greatly with the spread of the Indus tributaries.

In 1959 the large- and medium-scale industries had increased production by 80 per cent over 1954; this was achieved with less than the planned investment which aimed at a 65 per cent increase. Progress in cottage industries was, however, far less than anticipated. In the First Five Year Plan most of the industrial development was channelled through the Government-sponsored Pakistan Industrial Development Corporation, whose policy was to restrict further growth in already established areas, such as Karachi. This is to be relaxed in the Second Five Year Plan with its increasing reliance on private enterprise; although some measure of control will still be exercised by the establishment of government industrial estates.

One of the key factors in the industrial development is power, and it is significant that the northern high tension grid is nearly complete. The gas pipeline is to be extended from Multan to link Lyallpur, Lahore, Jhelum, Daud Khel and Rawalpindi to the ample high-quality natural gas reserves of Sui and Mari (10 mill. mill. cu. ft.) which in 1959 had an output of 22,500 mill. cu. ft. Oil was struck at Balkassar late in 1959 and, although reserves are small, the field accounts for the present 15 per cent increase in output. Coal supplies are at present mainly from the Makerwal area, although the major developments and hopes for the future are pinned on the Sor Range south of Quetta. In addition to increasing national output this could also stimulate new development in this isolated region.

Owing to the erratic flow of rivers, thermal power stations are frequently essential to supplement hydro-electric plants, especially following the difficulties in fulfilling the H.E.P. aims of the First Plan. Of the major multi-purpose projects only Taunsa is on schedule; Warsak should be completed this year, but its irrigation works are a year in arrears; Guddu and Kotri are now expected to be completed in 1962 and 1963 respectively. The



Kurramgarhi project illustrates the difficulties encountered in many stations; of a planned 4000 kW output, only 2200 kW is being produced, and the irrigated area has proved less extensive than was anticipated.

The Second Plan continues the high expenditure on transport—1450 miles of roads are to be improved and 2075 miles of new roads built, representing a total increase of 7 per cent. New bridges will be constructed near Thatta (Indus), Bahwalpur (Sutlej), Lahore (Ravi), and at Jhelum city. In contrast many railway branch lines are to be closed in the interests of economy and efficiency.

The national economy will continue to be dependent upon agriculture whose products earn 90 per cent of its foreign exchange and supply raw materials to its growing industrial sector, as well as feeding Pakistan's growing population. Non-industrial market towns such as Montgomery will therefore continue to play an important part in the future. (*Sources*: Government of Pakistan Planning Commission: *First Five Year Plan* 1955–1960, Karachi, 1958; *Second Five Year Plan* 1960–1965, Karachi, 1960.)

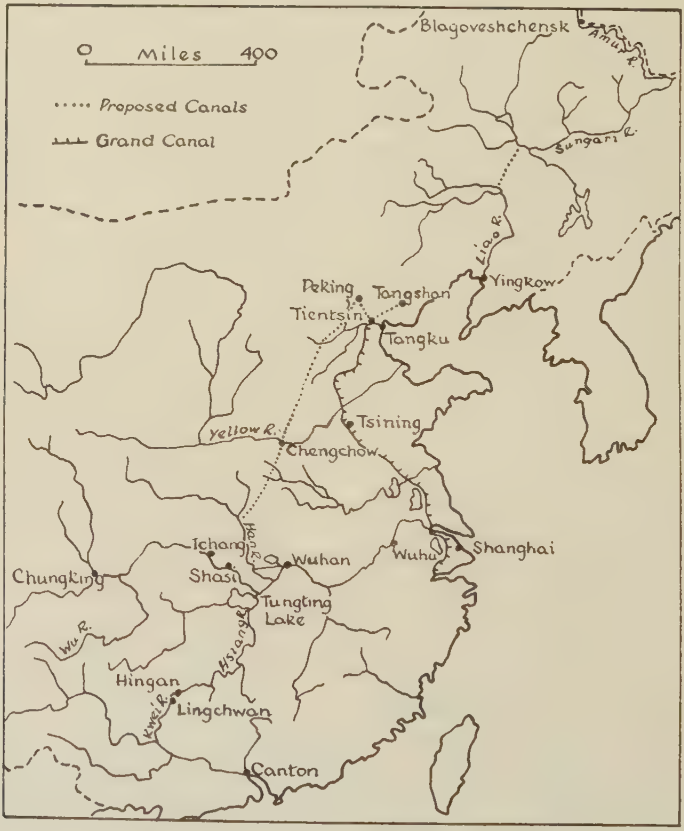
Keble College, Oxford M. R. Brearey and B. S. Connock

THE DEVELOPMENT OF CHINA'S INLAND WATERWAYS

The spate of official reports describing new developments in China has recently revealed increased government interest in the construction and renovation of inland waterways. The well-publicized extension of the railway network has been rapid, but it has involved the use of much iron and steel, vital commodities of which China is still desperately short, and also a relatively large capital expenditure. In September 1959, the Chinese Communist Party Central Committee and the State Council issued a directive on the development of a renewed campaign to expand transport facilities which stated in part "In all localities where there are rivers, an active effort should be made to harness them in order to make them as navigable as possible"; and a clue to the present attitude of the government towards the development of inland waterways was given in an editorial in the official *Jen-min Jih-pao*, Peking, in the following December which stated "The development of waterways transportation is a project requiring relatively little investment, while the volume of transportation can be tremendous."

During 1960 improvements in waterborne transportation facilities have been reported from many parts of the country. Work which has been proceeding on the northern border since 1955 to improve the Amur River for navigation was made public in February 1960. Shoals in the middle section of the river from Blagoveshchensk downstream to Khabarovsk are being removed. The work is under the joint control of Chinese and Soviet engineers and proceeds mainly in the winter when the river is frozen. Dangerous shoals in the middle and lower reaches of the Wu Kiang, a tributary of the Yangtse, have been removed by blasting, opening a 593-kilometre stretch in Kweichow province for navigation. Pig iron, tung oil, grain and phosphorus ores have been reported passing along the river from northeast Kweichow bound for Wuhan and Shanghai. Dredging is going on to rejuvenate the 2400-year-old Grand Canal and construction work has begun on a 110-kilometre extension from it at Tientsin eastwards to Tangshan in order to serve the Kailan coal-mining area. Work on the Canal itself is at present concentrated on that part of the channel between Tsining in Shantung and the River Yangtse, a 510-kilometre section. Many improvements in navigation are being carried out in conjunction with irrigation and flood control projects. The Wang and Chien rivers flowing into Tungting Lake were reported in October 1960 to have been regulated by a series of small reservoirs. Included in the scheme was the construction of 300 kilometres of trunk canals on which navigation is possible by small steamships and junks. Progress has even been reported from Tibet, where preliminary work has been started on opening up the Lhasa River and part of the Tsangpo for navigation by 50-ton craft.

But the most significant improvements concern the 5500-kilometre River Yangtse, reported in March 1960. The government established the Administrative Bureau for Yangtse River Navigation in 1949 to control wharves and shipping along the river; in 1956 all river shipping was brought under "unified management". A large-scale attack on obstacles to navigation has been taking place since 1953. The well-known bottleneck at Tienhsing Chow, near Shasi, where silt used to pile up during the low-water season, is now navigable at all times. At Kungling, above Ichang, the bed of the river has been widened from 30 metres to 60 metres by blasting. A system of over 5000 navigation lights, based on Soviet methods, has been working along the whole navigable length of the river since 1954, making it possible to pass through the gorges betweeen Ichang and Chungking by night and reducing the duration of the steamship voyage between Ichang and Chungking from four to two days. Conversion of the lighting system from oil to electricity was started in 1958 and finished in September 1959. Improvements in the river ports are also being carried out. Two completely new ports were constructed during the First Five Year Plan (1953–7): at Chiulungpo in the Chungking municipal area for steel products and at Yuhsikou in Wuhu, Anhwei province, for coal. The authorities claim that the river is now carrying six and a half times more freight than it did ten years ago. (It should, however, be noted that traffic along the Yangtse was unusually small



in 1949–50 because of the political situation.) Grain is reported to be the biggest item at present, followed by coal, ores, steel, timber and mining equipment. Some passenger ships of the Soviet Volga type have been introduced in recent years. The next step will be to deepen the channel between Ichang and Chungking to a uniform 9 metres. Chungking will then be accessible to 5000-ton ships.

The piecemeal improvements outlined above are based upon an overall development plan released by Peking in May 1956. Its main feature, shown on the accompanying map, is the eventual linking up of the four main river systems of China—the Amur-Sungari, the Yellow, the Yangtse and the Si Kiang—by transverse canals capable of taking 500-ton river boats. Proposals have been made for a 300-kilometre Sungari-Liao Canal in the north between the Sungari and West Liao rivers, via Talai, Ankuang and Taoan, to link up the Amur, Sungari and Liao rivers. This canal will give access to the sea at Yingkow. Peking is to be linked to the sea through the dredging and widening of an old canal to Tientsin. This will allow 3000-ton steamers to travel from the large new port at Tangku, which was opened in 1952, via the Hai River directly to the capital. The improved 1700-kilometre Grand Canal will play an important part as a link between Tientsin and the Yangtse; but another connection further to the west has also been planned, running from Peking to Chengchow and then, as the 466-kilometre Yellow-Han Canal, connecting the Yellow and Han rivers between Chengchow and the Tankiangkow Reservoir. The final link in the network will be the 30-kilometre Hsiang-Kwei Canal following the line of an old canal between Hingan and Lingchwan in Kwangsi, which will give access from the Yangtse system to south China.

Rhoads Murphey (*Economic Geography*, vol. xxxii, 1956, p. 28) has expressed doubts about the wisdom of the rapid expansion of China's railways, arguing scarce Chinese capital might be better invested in the waterways: "The example of the Rhine, which still carries more traffic than the combined railways through its basin (and at lower cost) should be suggestive to China, where the Yangtse system is larger and at least equally well placed to serve a majority of domestic and export flows." A scarcity of river shipping would, however, prove a major factor preventing any further speeding up in the rate of inland waterway development. Most of the larger ships on the inland waterways before 1949 were foreign owned and were withdrawn before the present government came to power; many Chinese-owned ships were taken to Taiwan by the Nationalists. Until June 1959, when they were reduced, long distance water rates along the Yangtse were as high as those for rail transport, and short distance rates have remained higher than rail. This is largely because of an acute shortage of mechanized craft on the river. (See *Survey of China Mainland Press*, American Consulate, Hong Kong; *China Reconstructs*, Peking; and the Union Research Service, Hong Kong.)

University of Hong Kong D. J. Dwyer

WAITAKI RIVER DEVELOPMENT

The Waitaki river, one of New Zealand's largest rivers, drains lakes Tekapo, Pukaki and Ohau, three morainic lakes situated at the foot of the Southern Alps here fringing a high intermontane plain making up the

Waitaki and Mackenzie basins. The plains and hill country through which the upper river flows are dry and tussock-covered, and utilized above Kurow for extensive sheep grazing on large properties of up to 100,000 acres; the fertile floodplain of the lower river is used for more intensive mixed farming. The Waitaki river is close to the load centre of South Island and its power can be developed with little disruption of settlement.

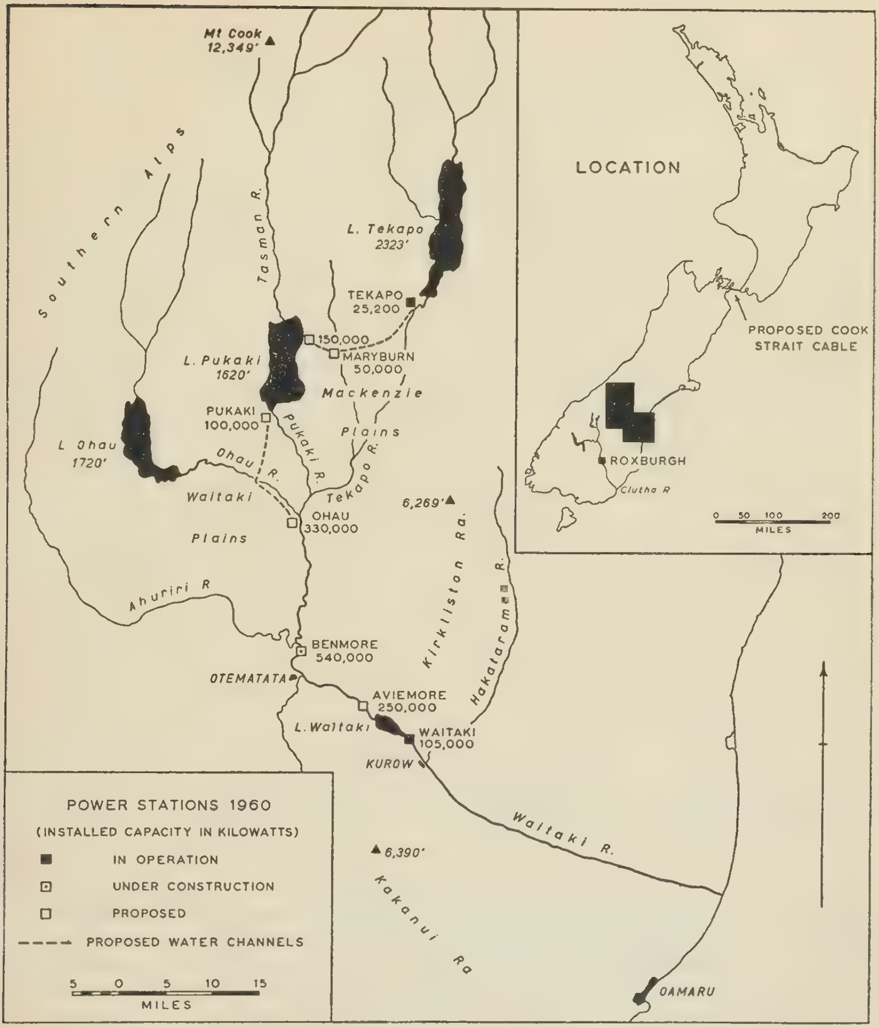
The demand for hydro-electric power, which contributes 90 per cent of New Zealand's electricity supply, is greatest in winter. The Waitaki, a snow-fed river, has a summer flow about 10 times greater than that of winter, so that storage of water is essential for power development. The lakes provide excellent natural storage facilities and at present the supply of water has been enlarged and regulated by control works at the outlets of the lakes Pukaki and Tekapo and electric power is generated by stations at Tekapo (25,200 kW) and Waitaki (105,000 kW).

Development of the river commenced in 1928 when the Waitaki power station, with its 120-feet high dam, was built without the aid of modern mechanical equipment. The first power was generated in 1935 and the station reached its designed capacity of 75,000 kW in 1949. With the completion of the Tekapo and Pukaki storage projects output was increased in 1954 to the present capacity of 105,000 kW. The construction of Tekapo power station, begun in 1938 and delayed by the war, was completed in 1951 when it added 25,000 kW to the total installed capacity.

The present works, commenced in 1957, involve the construction of a dam and power station at Benmore. The dam just below the confluence of the Ahuriri river with the Waitaki will form a lake covering 30 square miles and extending 16 miles up the main river—the largest man-made body of water in New Zealand. Situated at the lower end of the upper Waitaki Gorge with its rock walls, this earth dam will be built more cheaply and quickly than the conventional concrete dam, have a crest length of 2000 feet and a structural height of 360 feet, and contain sixteen million cubic yards of filling whose materials are all located within easy access. When completed in 1965 the project will have cost £30 million. The power station will have a capacity of 540,000 kW, the largest in New Zealand, exceeding the 320,000 kW Roxburgh station on the Clutha river. It will produce more electricity than any other single station in the southern hemisphere excepting Kariba.

Besides the production of electric power the Benmore project will assist in river control and flood reduction. Proposals have been made for irrigation schemes in parts of the upper Waitaki basin. Three miles below the dam site a new town, Otematata, has been constructed to house workers during construction; with a labour force of almost 1000 and a population approaching 3000, this town has become an almost self-contained unit with little dependence upon the nearest considerable settlement, Oamaru (population 12,000), some 60 miles away. But it will not all be gain, for when the lake fills behind the dam, about 30,000 acres of tussock grazing will be lost and a number of old, faded Maori or "Moa-hunter" drawings in cave shelters in the Waitaki Gorge will be drowned.

The present works may only be a stage in the full development of the Waitaki basin. From Lake Tekapo to Kurow there is a fall of some 1700 feet and the total potential of the basin is estimated to be over 1·5 million kW (New Zealand's present total installed capacity is 1·2 million kW). A



station is planned to be built at Aviemore (est. output 250,000 kW) and other stations, whose tentative locations are indicated on the map, could add a further 600,000 kW. The development of these, however, is probably dependent on the proposal to transmit electric power by submarine cable across Cook Strait. North Island, with a much greater population and demand for power than South Island, has developed most of its own potential; it has been suggested that it would now be more economic to produce power in South Island for export to North Island than to build expensive stations in the latter. It seems likely that the Waitaki river would be used to meet this demand, for South Island may well be unable to use all the available power even from Benmore within the next decade. Thus from being an entirely pastoral area prior to 1928, the upper Waitaki basin has assumed a new role as a major source of hydro-electric power for New Zealand.

New Zealand L. J. STENHOUSE

The Geographical Association

OFFICIAL INQUIRY

It is likely that the Association may be invited to submit evidence to the Central Advisory Council (England) of the Ministry of Education which is "to consider the education between the ages of 13 and 16 of pupils of average and less than average ability who are or will be following full-time courses either at school or in establishments of further education. The term education shall be understood to include extra-curricular activities". Members who have knowledge of pupils within these categories may wish to submit suggestions from their experience connected with the teaching of geography, and they are invited to send such information at an early date to the Honorary Secretary at headquarters office. This is a matter of importance and urgency and the practical views of members will be particularly appreciated.

BRANCH NEWS

Branch activities have been resumed in Luton and District. Members in the area should write to Mr. A. D. Cooper, Luton College of Technology, Park Square, Luton, for details of the programme arrangements. A new branch has been formed at Wolverhampton and Mr. K. C. Girkin, 71 Elizabeth Avenue, Goldthorn Hill, Wolverhampton, will supply information about activities.

LIBRARY CLOSING

The library of the Geographical Association will be closed from 29th July until 14th August, 1961.

SUMMER SCHOOL IN GERMANY

Members who are interested in this course (18th August to 2nd September, 1961) should write to headquarters office to inquire for vacancies which may occur through cancellations. The centres are Kettwig (Ruhr) and Tübingen (Wurttemberg).

BRITISH LANDSCAPES THROUGH MAPS

The third book in this series, *Guernsey*, by Professor H. J. Fleure, is now published. Like Nos. 1 and 2, it describes the country on an Ordnance Survey map (in this case the three inch to one mile map of the island of Guernsey) and is illustrated with maps and 16 photographs. Its price is 4s. 6d. (to members 3s. 6d. or, for orders of 12 or more, 3s. 3d.).

LIBRARY NEWS

The Association continues to benefit by the exchange of journals with other organizations. New exchange arrangements include:

Regio Basiliensis, Société de Géographie et d'Ethnologie de Basel, Klingelbergstrasse, 16, Basel, Switzerland.

Revue Géographique de l'Est, published by the Institut de Géographie, de Besançon, Dijon, Nancy et Strasbourg for the Association Géographes de L'Est, 13 Place Carnot, Nancy, France.

A supplement to the *Annals of the Association of American Geographers*, vol. 49, September 1959, is a symposium on "Man, Time and Space in Southern California".

The Standing Conference for Local History has published "Local History Series" which could be of much use to teachers of geography: *Recording Local History* (No. 5, 6d.); *Local History Exhibitions* (No. 6, 9d.); *How to Write a Parish Guide* (No. 7, 9d.); *Discovering the Past* (No. 8, 2s. 6d.); *Local History in Schools* (No. 11, 2s.); *Introducing Local History* (2s. 6d.). They can be obtained from the National Council of Social Service, 26 Bedford Square, London, W.C.1 (postage should be added).

Reviews of Books

With very rare exceptions books reviewed in this journal may be borrowed from the Library by full members and student library members of the Association.

A Social Geography of Belfast. E. Jones. 14 × 22·5 cm. xiv + 299 pp. London: Oxford University Press, 1960. 35s.

This book is more than a pioneer study of Belfast; it is a contribution to the literature of British regional geography as well as to that of urban geography and sociology. In the first two parts the natural stage is set and historical prologue read, but the greater part of the book is a description of the various physical and social elements which go to make up the urban scene. The descriptions are vivid and full of detail; the analysis, illustrated by some ingenious diagrams, lively and stimulating. In Belfast with its religious divisions and segregation, the social aspect is particularly fascinating. Some may feel that undue attention is paid to what they consider esoteric detail, such as age and type of houses. But, to a large extent, a town is its own environment; although at initiation the natural environment may be critical, it is the social and economic environment that conditions growth; the urban landscape provides its own physical basis.

This description of Belfast is developed with an evolutionary theme and occasionally one wishes for more incidental information, e.g. as to the sources of the capital which made growth possible. A theory of growth is the core of the book and the chapters on Urban Landscape Regions and Theories of Growth might form part of a textbook of geographical method. Analytical study of this kind represents a tremendous advance on mere factual description. The difference is, perhaps, that between scientific geography and mere topography. Besides its intrinsic value as a study of a British city, the book should prove stimulating to any student about to embark on a regional study, urban or otherwise. It is unfortunate that the price is so high for it ought to be read by any sixth-former aspiring to an honours course in geography.

H. A. M.

Provinces of England. A study of some geographical aspects of devolution. C. B. Fawcett. Revised by W. G. East and S. W. Wooldridge. 14 × 22 cm. 192 pp. London: Hutchinson and Co. Ltd. 1960. 21s.

Provinces of England was published first in 1919. The revisers justify its reissue on the grounds that its theme remains topical, and that the book has original merits of its own.

Fawcett's work was based upon the notion that England would be better governed as a federation of provinces with provincial parliaments and some (not very clearly defined) devolution of power to them. Most of the text is devoted to the size, shape and identity of the provinces. Fawcett was clearly right in saying that "full provincial devolution in a parliamentary sense" was neither expected nor demanded in England in 1919. It is even less demanded or expected today. One important development has, however, taken place in this field since 1919, and this is the establishment of regional offices of the central government. The territories of these are, in geographical terms, very clearly the collaterals, if not the descendants, of Fawcett's provinces; and the terms in which discussion of the future of county government is conducted suggest that they will remain so. Professors East and Wooldridge add a brief discussion of the nine Census "Standard Regions" of England, which appear to be approximately the same as those used by the many Westminster departments which maintain regional offices. A fuller discussion of these from the standpoint of Fawcett's provinces might have shed much fresh light on both.

More than one of the reviews of the original issue of *Provinces of England* concluded by saying that the book's particular merit lay in its presentation of familiar material from a novel standpoint. This remains a fair conclusion.

F. A. L.

The Concise Oxford Dictionary of English Place-Names. Eilert Ekwall. 4th edition. 16·5 × 24 cm. lii + 546 pp. London: Clarendon Press, Oxford University Press. 1960. 50s.

Professor Ekwall's dictionary of English place-names is too well known to need any introduction to geographers. For the last quarter of a century it has provided them with an indispensable guide to the meaning of the chief names of this country. (A review of the first edition of 1936 may be found in *Geography*, vol. 25, 1940, p. 144). Since the appearance of the first edition the English Place-Name Society has published detailed information for no less than eleven counties and much other research has also been undertaken, with the result that a considerable amount of additional material has become available. Some of this had already been incorporated into the second and third editions by means of appendixes but this time "The dictionary has been reset, all material in appendixes having been worked into the text together with a considerable body of fresh additions and corrections. Many articles have been rewritten." The result is a first-class work of reference which is a fitting tribute to the profound scholarship of its distinguished author.

I. S. M.

The Making of the Broads. A Reconsideration of their Origin in the light of New Evidence. Royal Geographical Society Research Series No. 3. J. M. Lambert, J. N. Jennings, C. T. Smith, Charles Green and J. N. Hutchinson. 18 × 25·5 cm. 153 pp. London: John Murray. 1960. 25s.

In 1952 Jennings published the results of his work on the Broads in R.G.S. Research Series No. 2. Lambert's later work in the Broads of the Yare valley gave strong evidence to suggest that the Broads were artificial, a mode of origin considered by Jennings, but rejected in favour of the hypothesis that they were initiated as a discontinuous series of natural lakes resulting from the marine transgression of Romano-British times.

In the present volume, all the evidence is re-examined and new material based on research in the fields of historical geography and archaeology is added. The conclusion is almost inescapable that the Broads are the result of the digging of peat in the medieval period, when sea level was relatively lower than today, followed by flooding as a result of a relative rise of sea level.

This book is essentially one for the specialist research worker rather than for the geography teacher. As an example of how complex and intricate problems should be presented it is, however, a model for all. Evidence is logically and systematically treated and fact is separated from theory. Difficulties are freely admitted and counter arguments fully discussed. The whole is well illustrated with maps and sections and some first-class oblique air photographs.

C. K.

The Relief and Drainage of Wales. A study in geomorphological development. Eric H. Brown. 16 × 25·5 cm. xii + 186 pp. + a folded map. Cardiff: University of Wales Press. 1960. 30s.

In this volume Dr. Brown gives a synthesis of the results of many years of painstaking and arduous work. Few people can have such an intimate and comprehensive knowledge of the physique of Wales and fewer still can be so well fitted to present an analysis of its landforms.

The highest peaks of Wales are seen as the possible remnants of a Sub-Mesozoic surface, exhumed and warped in early and mid-Tertiary times. The remaining area above 700 feet is explained in terms of three partial peneplanations in the later Tertiary, while the transgression and regression of an early Pleistocene sea is invoked to account for the platforms, interpreted as wave cut, which can be seen at various levels below 700 ft.

Any interpretation of this type can be no more than a working hypothesis which may well be modified in the light of further studies. Dr. Brown does not claim any higher status for this present work. Indeed, one of the more important conclusions of the book—that the erosion surfaces above 700 feet are sub-aerial in origin and owe nothing to wave cutting— is a modification of his earlier views. His opinion that all the surfaces below the 'summit plain' are unwarped is completely contrary to the views expressed by O. T. Jones. Clearly the last word has not been spoken.

Despite a clarity of presentation which results from a lucid style, combined with a wealth of clear line diagrams and maps and with photographs which are usually good, this is not an easy book to read. Much of it can only be followed with the aid of large-scale maps.

There can be little doubt that this volume will take its place among the classics of landscape interpretation, or that it will exert a continuing influence on future work, not only in Wales but also in a much wider field.

C. K.

Scolt Head Island. J. A. Steers (ed.) Revised edition. 18 × 24 cm. xi + 269 pp. + 29 plates. Cambridge: W. Heffer & Sons Ltd. 1960. 50s.

The new edition of *Scolt Head Island*, edited by Professor Steers, has brought up to date the detailed description of this very interesting part of the north Norfolk coast. From the geographical point of view the first 8 chapters are the most valuable. The last 8 deal in detail with biological aspects of the area. Chapter 4, by Professor Steers, which deals with the physiography and evolution of the island, is of particular interest and chapter 8, by Professor V. J. Chapman, which discusses the plant ecology very thoroughly, is of great value and presents many useful data to those interested in dune and marsh vegetation. One minor point may be mentioned; *Suaeda fruticosa* grows in Lincolnshire north of the line indicated in fig. 30.

Professor Steers's contribution describes the dunes and marsh clearly, giving useful information on marsh accretion. He then considers the active processes and discusses the origin of the island and recent changes in it, placing it in the wider setting of the whole north Norfolk coast. The discussion of the shingle ridges, which form the foundation of the island, suggests that the fundamental processes on which their formation depends are still inadequately understood.

The book is well produced and illustrated with many maps and diagrams. Photographs, many taken from the air, are grouped at the end.

C. A. M. K.

The Mediterranean Lands. D. S. Walker. 14×21 cm. xxiii+524 pp. London: Methuen & Co. Ltd. 1960. 42s.

This attractive volume will greatly extend a sixth former's knowledge but will not greatly deepen his geographical thinking. Thus the 51 pages of general introduction are too short, the account of the sea itself and of the soils being especially deficient. Geological and biological facts are abundant but explanations are on rather an elementary level. The balance of space given to each country is satisfactory but the sections on Jugoslavia and the Middle East are the least factual. Sixty-three well-chosen, really geographical pictures on thirty-two plates are rarely referred to in the text and would benefit by greatly expanded explanatory captions. The sketch maps are neat but elementary. The historical material provided is first-rate, but one regrets the author's deliberate decision to exclude a general historical introduction, for sixth formers will need orientation in this respect. The author's judgement on political matters is rather too safe to be stimulating.

The metric system is much used and this is good practice for sixth formers. The glossary of foreign words is unnecessary as they are explained in the text. The bibliography, largely of historical and current affairs, is barely full enough, especially in its references to journals. The style is on the dull side, perhaps because it carries too heavy a burden of relatively trivial facts. More of the real problems of the Mediterranean world should have been selected for study. Thus the soil and climatic problems require a more technical discussion. A more advanced account of characteristic village and town developments, details of land tenure, and the exact methods of irrigation, using sample studies and precise scientific description would have remedied some deficiencies. This, then, is an excellent book for all but the best pupils who will insist that there is something a little more fundamental in geography. The general reader and the school librarian will find the book a fascinating compendium.

D. J. D.

West Africa: A Study of the Environment and of Man's Use of it. Geographies for Advanced Study. 2nd edition. R. J. Harrison Church. 14·5 ×22 cm. xxvii + 547 cm. London: Longmans, Green & Co. 1960. 50s.

This second edition is timely, not only because of the recent pace of change in West Africa but also because this notice of the book is the first to appear in the pages of this journal, an omission which has afforded time for a more intimate assessment of its worth, and an opportunity to reflect on the opinions of its reviewers elsewhere.

It is the first modern survey of the whole of West Africa in English at university level. For this in itself it deserves considerable credit, but further commendation is due for its compendious résumé of facts, the careful index, the generous bibliography, the numerous new illustrations, an easy style, and a serious approach to social problems—not since Pelzer has a tropical region received such sympathetic treatment in the English language. Yet the book has suffered some severe criticism, simply for its bravado in venturing into virgin territory armed only with the stereotyped "European" regional approach, such as every graduate has come to understand and expect. To cavil over this is openly to condemn too many sets of lecture notes. For critics to expect an expert assessment of the ethos of West Africa and a detailed appreciation of its regionalism in realistic ethnographic, historical and cultural terms is to ask the impossible. Our present knowledge and the present spread and intensity of geographical research in all the territories will not allow of this ideal for some time to come. The academic regional analysis of these vast areas had to be attempted and if the perfectly balanced survey of physical, economic and anthropological influences is ever to be written it will only appear after a lifetime of detailed research in the regions themselves. Although faults of emphasis and approach may be apparent wherever he appears to trespass into anyone's "private domain," the only serious crime that Dr. Harrison Church seems to have committed is to have been first in the field, and to have been ably backed by his publishers.

R. W. C.

Minnesota's Changing Geography. J. R. Borchert. 21·5 × 2·75 cm. vi + 191 pp. Minneapolis: University of Minnesota Press. London: Oxford University Press. 1959. 34s.

Geographers familiar with Professor Borchert's substantive work will be interested in his attempt, in the present book, to write at the school textbook level. It can be said at once that he has succeeded very well indeed. No hint is given of the age group for which the book is intended, but with its wealth of illustrations and clear, uncluttered maps—most of which show only one distribution at a time—it can hardly fail to interest children from, say, eleven up to the age when they begin to become embarrassed by the rather frequent exclamation marks in the text. The coverage of the State's geography is full, beginning with the natural background, and including not only agriculture and industry but also consideration of social patterns—marketing, types of housing and what the young geographer will one day learn to call urban functional zones (the author uses little jargon, but does not shy away from technical terms, properly explained). With Professor Borchert as the book's author, teachers are assured of both quality and accuracy in the presentation of his material.

J. H. P.

North America. A Regional Geography. J. H. Paterson. 14·5 × 22 cm. London: Oxford University Press. 1960. 37s. 6d.

This beautifully written and composed book is admirably suited to Advanced level and early university work. It is a regional economic geography placing emphasis upon the history, economic forces and politics which shape the life of the continent. Geography provides the background to these human forces. The introduction of 187 pages contains an original chapter on "Conditions of Economic Development". The chapter on the physiographic divisions, climate, soils and vegetation is too short and elementary. A weakness of the book is the very cursory treatment of major subjects of physical geography. It lacks, for instance, a detailed description of permafrost, of the cause of mineralization in the Pre-Cambrian area, detail of soil formation of modern meteorology, of hurricanes. "What is kudzu or lespedeza?" a schoolboy might ask. There are too few detailed studies of typical American industries, e.g. the automobile industry. The author has attempted a different balance. The general section is followed by twelve fine regional chapters; one wishes they were longer. They characterize conditions in each region, excluding the more usual yard-by-yard survey studded with place names. Thus the location maps might be replaced by more original maps of selected towns, farms, industries, irrigation systems etc. An ample bibliography refers to detailed works in accessible journals and to *National Geographic Magazine* pictures. In the next edition the dates of these journals should be provided in addition to the volume number. A judicious use is made of statistics.

The author plans not "the transmission of new facts" but the "arrangement into more significant patterns, of facts which are already known". One might wish he had also extended this rather familiar range of facts.

D. J. D.

The Journal of Christopher Columbus. Translated by C. Jane. 17·5 × 25 cm. xxiii + 227 pp. London: A. Blond and The Orion Press Ltd. 1960. 45s.

This is a splendid book, which will grace any library, and is sure to capture the imagination of young and old alike. It is the narrative, day by day, of the most exciting voyage of discovery ever made. It is based on the log book of Columbus, who was unquestionably a genius with a gift for seeing and describing. The translation by Cecil Jane has been revised and completed by the distinguished Spanish scholar Vigneras. R. A. Skelton, of the British Museum, has contributed a splendid appendix giving the maps of the period in their context. The book is beautifully illustrated with 90 prints and maps of remarkable interest and value, so that it is a library collection in itself.

Vigneras relies heavily on Morison, even in his absurd attempt to explain the false latitudes of Columbus in Cuba. Skelton has argued skilfully for a Martellus World Map prototype which Columbus might have used on his first voyage. He adopts the traditional view that Columbus was in search of Asia. He is on doubtful ground in considering that the Zorzi sketch maps represent the views of the Columbus brothers, and in his view that the new lands to the west, shown on the Cosa map, were intended to be an extension of Asia; but he is to be warmly congratulated on a very able and illuminating contribution which adds greatly to the significance of the work. The maps are well reproduced and this book can be most confidently recommended in every way.

A. D.

Applied Geography. L. Dudley Stamp. A Pelican Book. 11 × 18 cm. 196 pp. Harmondsworth: Penguin Books. 1960. 3s. 6d.

Those who ask the question: "Is geography of any direct, practical use?" would be well advised to read this little book. It is written along the lines of a course given by the author at the London School of Economics when he occupied the Chair of Social Geography in the University of London. If the past fifty years have been spent in developing geographical methods of survey and analysis, Dr. Stamp argues, surely the time has now come to apply those methods towards the understanding and solution of some of the world's great problems. The applications being sought, he reminds us, are for the benefit of society.

Having defined the field of applied geography, the author proceeds to examine a number of problems. The treatment is not uniform throughout nor would one wish it so. Reflecting the importance of the subject, as well as the author's special interests, the heart of the book—over two-fifths of the text—is concerned with land-use survey, analysis and planning. In the longest chapter, entitled Land Planning, Dr. Stamp is at his best, cutting through the ramifications of competing land-requirements with a masterly command of fact. Most of the other chapters, dealing with population, town and country planning, photogeography, climatology, urban and industrial geography and trade, are very brief, often indicating little more than major lines of study; but they are valuable and one wishes that the author could have arranged space for more detailed discussion. One wishes also that more space could have been allotted to the underdeveloped countries where there is undoubtedly great scope for applied geography.

A minor weakness, which could be remedied in a later edition, is that various authors' names are mentioned in the text without an indication of the titles of the works in question; another is the absence of a guide to further reading.

The declared object of Dr. Stamp's book is to arouse interest. This it will certainly do. Important problems are lucidly examined with an admirable economy of words. Geographers and general readers alike will find this a stimulating book.

J. H.

Land for the Future. M. Clawson, R. Burnell Held and C. H. Stoddard. 16 × 23·5 cm. xix × 570 pp. Baltimore: Johns Hopkins Press. London: Oxford University Press for Resources for the Future, Inc. 1960. 68s.

This book deals exclusively with the United States. Despite the vast extent of the country which gives every American a land inheritance more than ten times that of a citizen of Britain, a population increasing at the phenomenal rate of 1·85 per cent per annum and now topping 180,000,000 is perforce turning the nation's attention to the growing pressure on land resources. So the problem which has dominated thought and action in Britain for the past twenty years—how to equate and satisfy the just but competing claims for land—is here examined in its American setting. In the Introduction a population of 310 million is postulated for the year 2000, with the most rapid increase in the west and least in the northeast, and with marked urbanization, as everywhere in the world. After a brief examination of the land in time and space—including changes in use—an interesting diagrammatic map graphically portraying how the country has shrunk from 1912 to 1950 in terms of time for travel from Chicago as a centre, the demands on land are considered in turn. The list is familiar: urban uses, recreation, agriculture, forestry, grazing, miscellaneous (including transportation, water supplies, mineral production, and wild life). Only in the separation of 'agriculture' and 'grazing' does the list differ from that normally used in Britain. In the United States farmland expanded till the 'twenties since when it has remained relatively constant in area, but output has doubled since 1910; a further intensification of production on the best farmlands is envisaged as able to take care of the food needs of the growing population. This reinforces the familiar British argument for conserving good land. Multiple use of land, so widespread in

Europe, is regarded as something of perhaps limited importance in the future. But the opinions expressed are based upon a wealth of statistics, carefully analysed, and this is a substantial book well worthy of study.

Manual of Photographic Interpretation. American Society of Photogrammetry. 18 × 26 cm. xv + 868 pp. Washington, D.C.: American Society of Photogrammetry. 1960. $12.00 or £5 5s.

As the title suggests this book is primarily a work of reference but what it does not convey is that the book deals almost exclusively with the interpretation of air photographs. As such it is of interest to the geographer, though only one of the sixteen chapters deals specifically with the interpretation of air photographs in geography. The first three chapters are of most general interest, covering the historical development of the technique, the procurement of air photographs and the principles behind their interpretation. The final chapter reviews the status of education in the technique in various countries, whilst eleven of the remaining twelve chapters deal with the interpretations of air photographs in various disciplines and applied fields; geology, pedology, engineering, forestry, wildlife management, hydrology and watershed management, agriculture, urban area analysis, archaeology and geography. There is a comprehensive glossary and an adequate index, and the book is profusely illustrated with line diagrams and both colour and half-tone photographs, including many stereopairs.

The American Society of Photogrammetry is to be congratulated on producing a more comprehensive guide to the interpretation of air photographs than any hitherto available in English. Duplication and certain errors are inevitable in the first edition of a work to which over one hundred specialists have contributed but some of the manual's shortcomings are all too obvious. The photographs are for the most part well reproduced but many of them lack scales whilst others have been reduced in scale to such an extent that they are virtually uninterpretable. The chapter on the interpretation of air photographs in geology contains a 46-page bibliography but the important chapter on the fundamentals of interpretation contains one of less than one page. The references are mainly to North American sources whilst, from the geographers' point of view, too few of the photographs are of areas outside North America.

G. M. L.

Geography in and out of School. Suggestions for the Teaching of Geography in Secondary Schools. E. W. H. Briault and D. W. Shave. 13·5×20·5 cm. 199 pp. London: G. G. Harrap & Co. Ltd. 1960. 9s. 6d.

Teachers and students will welcome this more substantial volume by the authors of the excellent pamphlet *Geography in the Secondary School* (Geographical Association new ed. 1960). The writers are at pains to point out that they have not aimed at the production of a comprehensive treatise on the teaching of the subject. Rather they have sought to stimulate interest in a wide variety of geographical techniques. The first section of the book discusses aspects of rural and urban field study, the second section methods of approach in the classroom and the concluding section the place of geography in the modern world. In certain chapters relating to the content of the course the approach is mainly philosophical, in others the authors have drawn upon their wealth of experience to put forward practical suggestions which will fully extend both teacher and pupil. Throughout, the writers have stated their views quite clearly without being in any way dogmatic. In particular they have entered special pleas for the introduction of some practical survey work for the concentric type of syllabus and for keeping abreast of recent developments. The book, which is attractively produced and moderately priced, is illustrated by numerous diagrams and some photographs. Appended is a useful bibliography of articles on the teaching of the subject which have appeared from time to time in *Geography.*

J. K. D.

The Junior Geography Lesson. E. J. Barker. 12·5 × 19 cm. 128 pp. London: Oxford University Press Ltd. 1960. 7s. 6d.

The publishers describe this book as "a very practical account of how to carry out modern methods of teaching geography to children between 7 and 11." The introductory chapter stresses the importance of careful planning using a variety of methods to stimulate the interest of the children. There follow chapters on using Pictures, Books, Models, The World Outside, and Maps, which give sound practical hints. However, some of the statements in Chapter 7 on maps are open to question.

In the next three chapters advice is given on the selection and treatment of material on the Local Area, The Homeland and The World while the final chapter is on planning the geography course. In the appendix are notes on books, world maps, and schemes of work. There are 23 maps and diagrams in black and white but the value of the book would have been enhanced had one or two photographs been included, e.g. to illustrate the method of picture study (p. 19) or to show actual exhibitions of work rather than theoretical ones.

The book is a most helpful guide for training college students and experienced teachers may well find in it some useful hints.

M. G. G.

Géographie. Collection André Journaux: Classe de Sixième by B. Pasdeloup, (3rd edition) 192 pp., 16s. Classe de Cinquième by F. Gay, 192 pp., 16s. 6d. Classe de Quatrième by R. Josse, 224 pp., 17s. 6d. 16 × 22 cm. Librairie A. Hatier, Paris, and Harrap & Co., London. 1960.

The use of illustrations in colour rather than in black and white as an accompaniment to geographical lectures is rapidly becoming the rule instead of the exception, and it is merely a matter of time before the application of colour gives added power to the photographs, diagrams and maps which enliven the pages of our school textbooks. In this direction the French are already ahead of the British, and these three volumes in the Collection André Journaux, printed by photo-litho, are excellent examples of how skilfully colour can enhance the value of a geography text.

The volume by B. Pasdeloup is intended for first-year work in a grammar school, and covers the general geography of the world. Outlines of global exploration, landforms and climatic conditions are followed by brief studies of life in the main regional sub-divisions of the world. There are 28 chapters, each devoted to a specific topic, and almost every page contains a map or illustration, clearly numbered to facilitate integration with the text and many of the photographs new to British readers. Variations in type and size of print give emphasis to geographical names and concepts which are also listed in a glossary on page 190, whilst there is a summary at the end of each chapter to assist the pupil in his use of the book.

Classe de Cinquième covers a journey through Africa, southwest and southeast Asia, Australasia and the Americas, giving a brief glimpse of each major land mass; thus Canada is dismissed in eight pages, Australia and New Zealand in six. In English schools this summary treatment of Commonwealth countries would be widely regarded as inadequate. Classe de Quatrième offers the traditional course for third-formers in French lycées, i.e. Europe and the U.S.S.R., omitting France but including the British Isles. They resemble their companion volume in appearance, layout, and in the use of colour.

About the time of the battle of Waterloo the senior forms in a certain progressive school in Birmingham were being taught geography through the medium of the French language. These three texts might well be employed by teachers of geography and French, at appropriate stages of their respective courses, and the *entente cordiale* would be to the mutual advantage of both subjects.

L. J. J.

Geography and Education. Ministry of Education Pamphlet No. 39. 18·5×24·5 cm. iii+62 pp. London: Her Majesty's Stationery Office, 1960. 5s.

The unnamed authors of this pamphlet deserve to be congratulated for compressing much sound advice and information within a brief compass. Most booklets of this size confine their attention to one sector of the educational field, but this one deals succinctly with a wide range of associated topics. Introductory chapters concerned with the stuff and structure of geography lead on to its treatment in primary and secondary schools, a section which occupies the middle half of the pamphlet. Geography in school, it is urged, should be both descriptive and explanatory—the phrase *description explicative des paysages* recurs in the text—and to achieve this aim the pupil should be encouraged to observe and record facts at first hand, as far as possible. A strong plea is accordingly made for field-work and local studies to supplement the attention traditionally given to more distant lands and peoples. Enlightened attempts to make geography real and vivid demand a wide repertoire of teaching aids, and an appendix offers useful hints on the accommodation and equipment considered desirable in a school geography department.

Facilities for travel have greatly expanded, and there is a more pervasive dissemination of news and ideas through the media of the printed word, the cinema, radio and television; in such a world, geography is a worthy item in the general education which enables adults to appreciate more fully the contemporary scene. The authors are optimistic about the value of geography to people of all ages and occupations, and they present it as a vibrant, living subject with a body of material which undergoes continual change and development.

Handsomely produced with colourful covers and a dozen black-and-white photographs, this booklet is good value for money and deserves to be widely read, inside and outside the profession of "geographer". It is pleasing to observe in it numerous references to the publications of the Geographical Association.

L. J. J.

BOOKS AND PUBLICATIONS RECEIVED

International List of Geographical Serials. C. D. Harris and J. D. Fellman, compilers. 193 pp. Illinois: University of Chicago Research Paper No. 63. 1960. $4. This "aid to geographers" is intended to provide a comprehensive inventory of all known geographical periodicals, both those currently being published and those no longer active.

Map Interpretation. G. H. Dury. xi+209 pp. 2nd edition with revisions. London: Sir I. Pitman & Son Ltd. 1960. 15s.

Some Problems of Human Geography. R. E. Dickinson. Inaugural lecture, March 1960. 36 pp. University of Leeds. 1960. 2s. 6d.

An Atlas of World Affairs. A. Boyd. Maps by W. H. Bromage. 160 pp. 3rd edition, revised. London: Methuen and Co. Ltd. 1960. 6s. 6d.

Chisholm's Handbook of Commercial Geography. Entirely rewritten by L. Dudley Stamp and S. Carter Gilmour. 915 pp. 16th edition. London: Longmans, Green and Co. Ltd. 1960. 70s.

British Agriculture. Structure and Organization. G. P. Hirsch and K. E. Hunt. 70 pp. Revised edition. London: Distributed by Evans Brothers Ltd., for the National Federation of Young Farmers' Clubs. 1960. 3s. 6d.

Printed Maps and Plans of Leeds, 1711–1900. Compiled by K. J. Bonser and H. Nichols. 148 pp.+12 folded illustrations. Publications of the Thoresby Society, Vol. xlvii, No. 106, 1958. Leeds: The Thoresby Society, 1960. 21s.

The Pattern of Service Industries in North-east England. B. Fullerton. 43 pp. Dept. of Geography Research Series No. 3. University of Durham King's College, Newcastle upon Tyne. 1960. 5s.

The Pennine Way. 250 miles along the "backbone" of England. K. Oldham. 69 pp. Clapham: Dalesman Publishing Co. 1960. 6s.

Peak District. National Park Guide No. 3. Issued for the National Parks Commission. Prepared by the Peak Park Planning Board. Edited by P. Monkhouse. 90 pp. London: H.M.S.O. 1960. 5s.

Derbyshire Lead and Lead Mining: A Bibliography. Compiled by R. A. H. O'Neal. 68 pp. 2nd edition. Matlock: Derbyshire County Library. 1960.

Yorkshire Field Studies. G. E. Bell (ed.). Board of Studies in Geography, University of Leeds Institute of Education. Occ. Papers No. 1. 148 pp. 1961. 5s. Fifty-four outline guides for field excursions in all three Ridings, with map references and bibliographies. This is a most helpful and admirable compilation, and an encouragement to teachers to bring field parties to Yorkshire.

Geologists' Association Guides. A series published to commemorate the Centenary of the Association. New issues: 9, The area around Sheffield. C. Downie. 24 pp. 1960. 3s.; 17, Geology around the University Towns: Swansea, South Wales. R. T. Owen and F. H. T. Rhodes. 20 pp. 1960. 3s.; 18, Geology around the University Towns: North-east Ireland—The Belfast area. J. K. Charlesworth and J. Preston. 30 pp. 1960. 3s.; 31, North-east Scotland: The Dalradian. H. H. Read. 17 pp. 1960. 2s. 6d. Information and copies from Benham and Co. Ltd., Culver Street, Colchester, Essex.

Britain's Structure and Scenery. L. Dudley Stamp. 317 pp. Glasgow: Collins' Fontana Library. 1960. 7s. 6d. Previously published in the New Naturalist Series, 1946.

Domesday Book and Beyond. Three Essays in the Early History of England. F. W. Maitland. 605 pp. Glasgow: Collins' Fontana Library. 1960. 8s. 6d. First published by Cambridge University Press in 1897.

Watermills with Horizontal Wheels. P. N. Wilson. 22 pp. London: Society for the Protection of Ancient Buildings, 55 Great Ormond Street, London, W.C.1. (Wind and Watermill Section.) 1960. 6s.

A Guide to Belgium for School Visits. D. J. Whittaker. 133 pp. Glasgow: Blackie and Son Ltd. 1961. 7s. 6d.

Southeast Asia. E. H. G. Dobby. 415 pp. 7th (revised) edition. London: University of London Press. 1960. 21s.

Ecuador. Country of Contrasts. L. Linke. 193 pp. 3rd edition. Issued under the auspices of the Royal Institute of International Affairs by Oxford University Press, London. 1960. 25s.

Statistical Abstract of Latin America 1960. Center of Latin American Studies. 48 pp. Los Angeles: University of California. 1960. \$2.00 or \$1.00 for more than 10 copies. Includes land use, populations, agricultural and manufacturing production by countries.

Report on an Economic Survey of Nyasaland 1958–1959. D. T. Jack (chairman). 300 pp.+7 maps and 2 folded plans. Office of the High Commissioner for Rhodesia and Nyasaland, Rhodesia House, 429 Strand, London, W.C.2. £1 10s. 0d.

Everyman's Classical Atlas, with an essay on the development of ancient geographical knowledge and theory. Everyman's Reference Library. J. O. Thomson. 125 pp. London: J. M. Dent and Sons Ltd. 1961. 18s. (Formerly known as *Everyman's Atlas of Ancient and Classical Geography.*)

The Teach Yourself Bible Atlas. Teach Yourself Books. H. H. Rowley. 88 pp. London: English Universities Press Ltd. 1960. 8s. 6d.

Geographical Articles

Listed from Periodicals received in the Library

CONTINUED FROM VOL. XLV, PP. 237 TO 240

Journals listed here may be borrowed from the Library by members of the Association. References are listed according to the classification published in the *Annals of the Association of American Geographers*, vol. xxvii, June 1937. Authors' reprints presented to the Library are included in the list of articles.

A of G—Annals of the Association of American Geographers. A of Sc—The Advancement of Science. BD—Berichte zur Deutschen Landeskunde. CGQ—Cahiers de Géographie de Quebec. EG—Economic Geography. EMG—East Midland Geographer. F—Fennia. FO—Focus. FS—Field Studies. GA—Geografiska Annaler. GJ—Geographical Journal. GNS—La Geografia Nelle Scuole. GR—Geographical Review. GRI—Geographical Review of India. GS—Geographical Studies. GT—Geografisch Tijdschrift. IANS—Izvestiya Akademii Nauk SSR. Seriya Geograficheskaya. IBG—Papers of the Institute of British Geographers. IG—Irish Geography. IGU—International Geographical Union Newsletter. JKC—Journal of the King's College, University of Durham. J of G—Journal of Geography. JTG—Journal of Tropical Geography. MW—Mitteilungen der Osterreichischen Geographischen Gesellschaft. PGA—Proceedings of the Geologists' Association. PV—Pacific Viewpoint. REC—Revue pour l'étude des calamités. RGL—Revue de Géographie de Lyon. SG—Soviet Geography. SGM—Scottish Geographical Magazine. SR—Sociological Review. TA—Tydskrif vir Aardrykskunde. TPR—Town Planning Review. UCH—University of Chicago Research Papers.

(E)—English summary. (G)—German summary. *—Maps.

GENERAL GEOGRAPHY. E. A. ACKERMAN, UCH, No. 53, '58.—Geography as a fundamental research discipline. D. A. ALLAN, SGM, Sept. '60.—John George Bartholomew: A centenary. H. X. L. CESAR, CGQ, No. 8, '60.—Solutions graphiques dans la cartographie des phénomènes quantitatifs. W. G. EAST, IBG, No. 28, '60.—Geography of land-locked states. C. D. HARRIS and J. D. FELLMANN, UCH, No. 63, '60.—International list of geographical serials. S. A. KORFF, GR, Oct. '60.—Geographical aspects of cosmic-ray studies. S. LESZCZYCKI, SG, Apr. '60. Latest approaches and concepts in geography. J. R. MACKAY, CGQ, No. 6, '59.—Regional geography: A quantitative approach. ROYAL GEOGRAPHICAL SOCIETY, GJ, Dec. '60.—Careers for geographers. A. S. SHAPOSHNIKOV, SG, No.?'60.—Participation of Moscow University geographers in practical work of regional economic councils. O. H. K. SPATE, A of G, Dec. '60.—Quantity and quality in geography. L. D. STAMP, A of Sc, July '60.—World land-use survey. U. TOSCHI, GNS, No. 5–6, '60.—La geografia scienza di vita. C. TROLL, A of Sc, Mar. '60.—The work of Alexander Von Humboldt and Carl Ritter. W. P. WEBB, A of G, June '60.—Geographical-historical concepts in American history. G. F. WHITE, J of G, Apr. '60.—Changing dimensions of the world community.

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